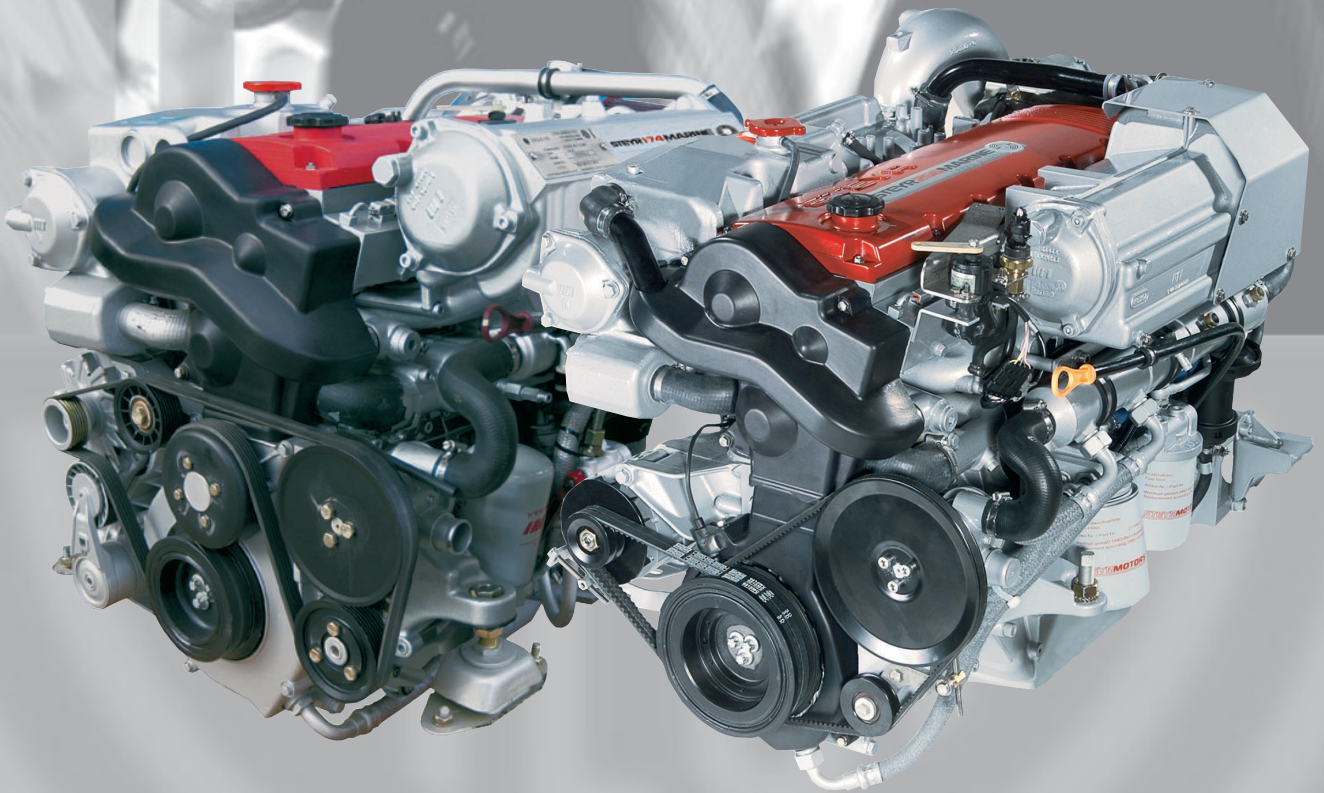




STEYR MARINE ENGINES

4 CYLINDERS + 6 CYLINDERS



INSTALLATION INSTRUCTION

P/N Z001007/0 4th Edition September 2007

There are two main purposes in publishing this book:

- a) To assist in the selection of suitable engines and auxiliary equipment for marine craft.
- b) To provide information in the form of technical data and installation "know - how" built up from our marine diesel engine business, enabling **4 & 6 Cyl. STEYR MARINE** engines of series to be installed in a manner which will ensure safety, reliability and ease of servicing.

Make sure to comply with all laws and regulations valid in the country of operation and for the respective type of boat.

It is particularly important too, to ensure that the engine installation complies with the Health and Safety Legalisation of the country of intended operation.

Before starting work, make a detailed planning, use true scale drawings and consider all assembly data available.

To guarantee a proper function of the engine and its built-on parts, the correct installation is of utmost importance. These works are to be carried out with greatest care. Make sure prior to assembly that true scale drawings and installation data are available, which will enable you to realize a satisfactory technical pre-planning and installation.

The engine compartment is to be designed in such a way that maintenance work on the engine will not be impeded. Consult the Operating Manual of the engine and the drawings. There should also be enough space to permit an inward- and outward lifting of the engine.

The installation is to be done in such a way that the engine is easily accessible for regular routine and maintenance works, in order to avoid unnecessary maintenance costs for the owner.

Product description, illustration and technical data

When reference is made in this manual to a brand name, a product number, a product or specific tool, an equivalent product may be used in place of the product or tool referred to, unless specifically stated otherwise. To exclude any possible danger, the operator has to provide for respective safety precautions.

All data, illustrations and specifications in this manual are based on the latest product data available at the time of printing. But it cannot be guaranteed that this manual will always be up to date. Revised versions with a later date of edition will replace all previous editions.

Warranty: This may be invalidated if the engine is not installed or operated / maintained according to STEYR MOTORS instructions.

The illustrations in this manual do not always come up to the actual equipments or components, and serve first of all as a reference.

STEYR MOTORS GmbH reserves the right to make changes at any time, without notice, as to technical data or models, and also to discontinue certain models. STEYR MOTORS GmbH also reserves the right to change any technical data or components at any time, without incurring any obligation to equip same on models manufactured prior to the date of such change.



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VERSIONS OF MANUAL

Version	Date	Modification
1.0	01. 11. 1998	First edition
2.0	01. 03. 1999	Modification
3.0	01. 04. 2006	Modification
4.0	01. 09. 2007	Modification

1. GENERAL

The installation of a marine engine is a very comprehensive task to be carried out with greatest care and attention. Before beginning, plan the execution and the works very carefully.

There should be space for the following components:

Control, manoeuvring apparatus, instrument panel with laced wiring harness, fuel tanks, pipings, batteries, engine compartment blower, air-vent conduits.

Don't forget that the engine compartment, the tank compartment and the battery box must be separated from each other, to reduce the danger of fire. In addition, separate fire extinguishers must be available, e.g. in the pantry, depending on boat size and type.

1.1. REGULATIONS

Note that each country has its own safety regulations as to installation. It is necessary, therefore, that the boatbuilder/engine fitter is aware of the safety regulations in his country, before beginning works.

1.2. RESPONSIBILITIES OF BOAT OWNERS

As a boat owner, you have certain responsibilities to others.

You are legally responsible for all occupants of your boat. Show all assistants the location of the emergency equipment and how to use it. You are required by law to have aboard one proper life jacket for each person, plus one approved throwable device for man overboard protection.

Learn the local waterway rules for boats and ships. Navigable waterways are controlled by Federal regulations.

Obey these regulations to protect yourself, your passengers and your fellow boating enthusiasts.

Thoroughly familiarize yourself with weather station warning systems and waterway nautical signals.

Contact your local Coast Guard station and take advantage of their seasonal boat inspections and training courses.

The manner and circumstances of the application, installation and use of the engine is not under the direct control of **STEYR MOTORS** and Steyr cannot be held liable for any loss or damage where the installer or user has not followed advice given by the Company.

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2. GENERAL INFORMATION ON INSTALLATION

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2. GENERAL INFORMATION ON INSTALLATION

NOTES

2. GENERAL INFORMATION ON INSTALLATION

2. 1. WEIGHT-DISTRIBUTION BALANCE

It is important that the heavy components, such as fuel tanks, water tanks and batteries are installed in such a way that the best possible planing position of the boat will be kept.

Of course the optimum gliding position differs from boat to boat but the best possible weight-distribution balance should always be the aim.



ATTENTION! ON ACCOUNT OF THE RISK OF EXPLOSION AND FIRE THE FUEL TANKS, BATTERIES AND ENGINES ARE TO BE PLACED IN WELL VENTILATED COMPARTMENTS SEPARATED FROM EACH OTHER. MORE DETAILS WILL FOLLOW.

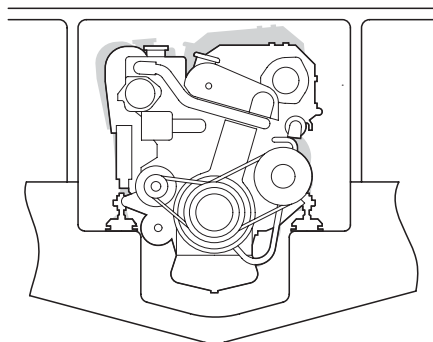
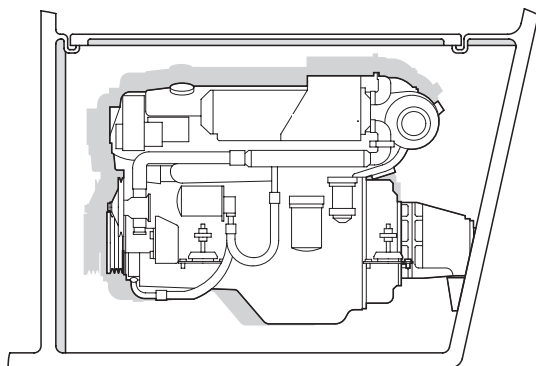
2. 2. ACCESSIBILITY

During assembly of the engine, take greatest care as to accessibility for service works.

An easy exchange of pump wheels, oil filters, air filters, water filters, fuel filters, V-belts etc. must be guaranteed.



ATTENTION! THERE SHOULD ALSO BE ADEQUATE SPACE FOR SOUND-ABSORBING MATERIAL. DIMENSIONAL DRAWINGS OF THE RELEVANT ENGINE MAY BE FOUND IN THE FOLLOWING CONTENTS.

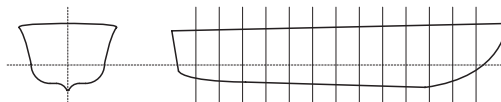


2.3. DISPLACEMENT OF WATER

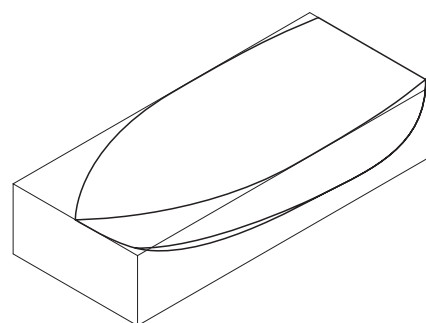
In order to determine the displacement of water of a boat, the weight of the boat should if possible be measured. If this is not possible and if there is also no model of the hull with the boatbuilder, a computation is to be made. Before beginning computing, the position of the water line should be checked on different points of the hull, and this with normal boat loading, since every change in weight has a strong effect on the speed of the boat.

At first, subdivide the hull into different sectors. Overlapping of the individual sectors with the actual waterline will result in different fields with different volumes, and by adding these volumes the displacement of water can be calculated.

For the accuracy of calculation the number of subdivisions is determining (e.g. Simpson's First Rule, Murphys Law...).



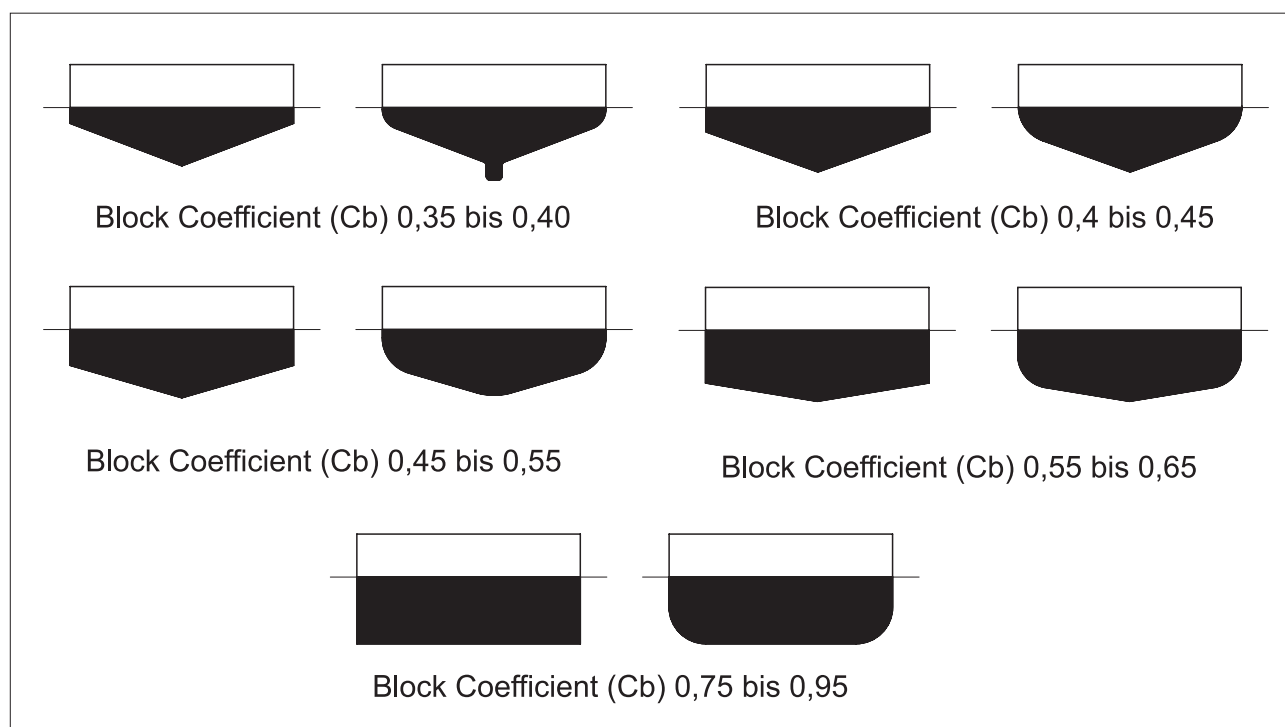
The displacement of water can also be determined by the **BLOCK COEFFICIENT** which, however, is more inaccurate. In this case, the difference between the volume of the keel and that of a body which intersects the outer edges of the boat is determined. But in practice it is very difficult to compute the volume of the keel.



2.3.1. Examples for the Block Coefficient

By means of the "BLOCK COEFFICIENT" the displacement of water can be estimated for every type of boat.

The value in ill. 14 refers to a section of the hull at the widest spot.



2. 4. SAFETY IN DEALING WITH FUEL AND OIL

Dangerous materials, according to accident prevention, are all explosive, fire-provoking, easy flammable, poisonous, injurious to health and corrosive materials.

In particular:

- cleaning gasoline
- mineral oil
- battery acid
- antifreeze
- varnish and dilutions
- solvent.

In case of **fire** of such materials, do not extinguish with water. Use carbon dioxide extinguishers or powder extinguishers. Notify the fire department.

In case of spilling such materials, e.g. while refueling, these are to be absorbed with sand, earth or suitable binding agents, and to be eliminated.



Attention: To avoid health troubles, the following items are to be considered:

- **Avoid direct contact with dangerous materials.**
- **Change clothing contaminated with dangerous materials as soon as possible.**
- **Do not keep oily cloths in your overalls.**
- **Clean oily parts of your body only with skin-care products (never use abrading sand or solvent).**
- **Never put such materials into drinks bottles.**

2.5. LIST OF FUEL AND OIL

Order No.	Qty.	Designation
VR00207/0	1	set of fuel and oil for engine service, consisting of:
Z010058/0	3	- STEYR Turbo Diesel motor oil SAE 5W-50 (4l. can.)
Z011785/0	3	- STEYR MOTORS engine coolant (5l. can.)
9000190/0	2	- hydraulic oil ATF (1l. bottle)
Z012222/0	1	- grease, Never - Seez; NS-160 B (1 kg can.)
Z909570/0	1	- caoutchouc sealing / electric contacts (148 ml can.)
9000059/1	1	- thread protection 243 (10 ml flask)
9000297/1	1	- surface sealing 509 (315 ml cartridge)
9000298/1	1	- surface sealing 5900 (300 ml cartridge)
9000019/1	1	- construction adhesive 620 (50 ml flask)
9000017/1	1	- construction adhesive 262 (50 ml flask)
Z010207/0	1	- contact grease (100 ml tube)
Z010226/0	1	- corrosion protection spray (400 ml can.)
Z010227/0	1	- corrosion protection wax (120 ml can.)
Z010084/0	1	- grease STABURAX NBU4 (1 kg can.)
Z010205/0	1	- fuel rust protection additive (5 lt can.)
9000197/0	1	- electric contact spray
Z011627/0	1	- silver varnish, RAL 9006 (1 lt can)
Z010074/0	1	- hardener varnish (0,5 lt can)
Z010075/0	1	- dilution for varnish (5 lt can)

2.5.1. Manuals

The following documentation is available in English language on our website:

<http://www.steyr-motors.com/technical>

technical documentation on CD - ROM	P/N Z 001009/0
operation-, maintenance & warranty manual for all marine engines	P/N Z 001022/0
tool catalogue for all marine engines	P/N Z 001002/1
spare parts catalogue STEYR 94 td diesel marine	P/N Z 001023/0
STEYR 144 vti/td diesel marine	P/N Z 001005/0
STEYR 164 td diesel marine	P/N Z 001015/0
STEYR 174 vti diesel marine	P/N Z 001011/0
STEYR 166 td diesel marine	P/N Z 011796/1
STEYR 236 FDE	P/N Z 011796/0
STEYR 236 td diesel marine	P/N Z 011796/1 - Z011769/2
STEYR 246 td diesel marine	P/N Z 011800/0
STEYR 256 td diesel marine	P/N Z 011810/0
STEYR 266 td diesel marine	P/N Z 011805/0
installation manual for marine engines	P/N Z 001007/0
service manual for all marine engines	P/N Z 001019/0
operator's manual marine gear ZF	P/N Z 001003/0
Diagrams marine engine functions on CD	P/N Z 001021/0

2.6. SI-SYSTEM

The following units are used:

units of length

km	=	kilometer
m	=	meter
mm	=	millimeter
"	=	inch
ft	=	foot
yd	=	yard
le	=	line

units of area

m ²	=	square meter
cm ²	=	square centimeter
ft ²	=	square foot
yd ²	=	square yard

units of volume

m ³	=	cubic meter
cm ³	=	cubic centimeter
dm ³	=	cubic decimeter
mm ³	=	cubic millimeter
ft ³	=	cubic foot
yd ³	=	cubic yard
l	=	liter

units of measure

t	=	ton
kg	=	kilogram
g	=	gram

units of force

N	=	Newton
kN	=	kilo Newton
daN	=	deca Newton

electric units

A	=	ampere
V	=	volt
W	=	ohm
μF	=	mikrofarad

fuel consumption

g/kWh	=	gram per kilowatt-hour
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units of pressure and tension

bar	=	bar
Pa	=	Pascal
N/mm ²	=	Newton per square millimeter

units of energy

J	=	joule
kW/h	=	kilowatt-hour

units of energy

kW	=	kilowatt
PS	=	horsepower

units of temperature

K	=	degree Kelvin
° C	=	degree centigrade

units of time

h	=	hour
min	=	minute
s	=	second

speeds

km/h	=	kilometer per hour
m/s	=	meter per second

speeds

rpm.	=	revolutions per minute
------	---	------------------------

2.7. ABBREVIATIONS

ill.	illustration
Cu	copper
HGrp	master unit
Max.	maximum
OT	top dead center
PTO	POWER TAKE OFF on crankshaft
SW	head width
wc	water column

2.8. GENERAL INFORMATION ON SAFETY

This section does not include the scope of general knowledge and the training of personnel as well as the "general rules of safety technics" and machine safety regulations - MSV.

Inappropriate behaviour and the ignorance of hazards during repair works may result in injuries to persons. The personnel on duty is to be trained accordingly and to be urged to respect the safety regulations.

2.9. GUIDELINES FOR DAMAGE PREVENTION

This section does not include the scope of general knowledge and the training of material maintenance personnel as well as the "general rules of safety technics" and machine safety regulations - MSV.

Inappropriate behaviour and the ignorance of material maintenance may result in considerable material damages.

While operating with fuel and oil, take care not to apply them on the surface of optical systems.

Lubricants should form a thin film on the surface, surplus lubricants must be removed.

2.10. LEGAL RULES

The following rules and guidelines are valid in Austria. For other countries, follow the local regulations.

2.11. DISPOSAL OF AUTOMOTIVE WASTE PRODUCTS

Used fuel and oil is to be collected in separate containers to permit an eventual subsequent treatment.



THE DISPOSAL OF ANY FUEL AND OIL FOR THE ENGINE IS SUBJECT TO THE SPECIAL WASTE ACT. THE "SPECIAL WASTE CATALOGUE" ÖNORM S2100 REFERS TO THE NECESSARY DISPOSAL IN AUSTRIA. PLEASE FOLLOW THE LOCAL REGULATIONS OF YOUR COUNTRY.

The operating and maintenance personnel has to take care that fuel and oil as well as other material ranking as special waste are deposited at the respective collecting points.

Code No.	Designation
31 423	oil contaminated ground or oil binder
54 102	waste oil
54 104	fuel
54 202	grease
54 207	vaseline
54 917	compact sealing material
54 927	oil contaminated scouring cloth
54 928	used oil- and air filters
55 510	colour- or varnish containing waste

2.12. SAFETY IN DEALING WITH FUEL AND OIL

Dangerous working materials, according to accident prevention, are all explosive, fire-provoking, easy flammable, poisonous, injurious to health and corrosive materials.

In particular:

- spirit
- mineral oil
- battery acid
- antifreeze
- varnish and dilutions
- solvents.

In case of fire of such materials, do not extinguish with water. Use carbon dioxide extinguishers or powder extinguishers. Notify the fire department.

In case of spilling such materials, e.g. while refueling, these are to be absorbed with sand, earth or suitable binding agents, and to be eliminated.

ATTENTION: To avoid health troubles, the following items are to be considered:



- Avoid direct contact with dangerous materials.
- Change clothing contaminated with dangerous materials as soon as possible.
- Do not keep oily cloths in your overalls.
- Clean oily parts of your body only with skin-care products (never use abrading sand or solvent).
- Never put working materials into drinks bottles.

2.13. MEASURES IN CASE OF ACCIDENTS

Products	First Aid		
	Skin	Eyes	Swallowing
Diesel fuel and mineral oil	remove contaminated clothing and thoroughly clean the skin with water and soap	rinse extensively with water for at least 10 min.	DO NOT VOMIT The greatest hazard after inadvertent taking consists in the fact that through aspiration liquid reaches the lung.
lubricating grease			
antifreeze		SEE THE DOCTOR	VOMIT SHOULD NOT BE STIMULATED. IMMEDIATELY SEE THE NEAREST DOCTOR
brake fluid			
battery acid			

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3. QUALITY DIRECTIVES FOR ASSEMBLY

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3. QUALITY DIRECTIVES FOR ASSEMBLY

NOTES

3. QUALITY DIRECTIVES FOR ASSEMBLY

For the assembly of spare parts, the manufacturer's instructions as well as legal regulations are to be considered. If repaired components or units are used as spare parts, the machining directives of the manufacturer are to be kept.

Safety components are components which due to a change of their initial form, their surface and material resistance will no more guarantee operating reliability and traffic safety and may cause considerable material damage or even personal damage. Such components may only be repaired or assembled if all testing and measuring instruments required for determination of component quality resp. proper conditions of installation are guaranteed.

Model-depending units and parts are components which are subject to approval in the course of standardization of the boat. Their failure means a risk for traffic safety.

Parts subject to design approval are components which are of particular importance for traffic safety and operating reliability, and which are approved with regard to their effectiveness, irrespective of the vehicle. In case of an exchange, such components may be replaced by design-approved parts only.

3.1. SPECIFICATION OF SPARE PARTS

Your **STEYR** diesel engine with direct fuel injection has been designed for high output.

Only use **GENUINE - STEYR - spare parts** to avoid any loss of efficiency.

You, therefore, should insist on the known quality of **GENUINE - STEYR spare parts** and should never use parts of unknown quality.

Chapter 17 (appendix) contains a proposal on spare parts.

3.2. WORKSHOP PROFILE

Irrespective of the individual repair steps and legal regulations, the workshop should meet the following requirements:

- clean, dry and dust-free ambiency
- lifting device (crane) with a carrying capacity of at least 5 000 N
- cleaning accomodation (washbasin) for contaminated components
- tool pertaining to commercial customs
- proper testing and measuring appliances
- collecting trays for fuel and oil.

Depending on the repair step to be carried out, tools according to the TOOL catalogue are to be procured. . In addition, procurement and stock of required fuel and oil, spare- and wear parts (e.g. seals, filters, anodes,..) is to be considered.

For authorized dealers and workshops, a minimum standard as to tools of stage I / service tools is required.

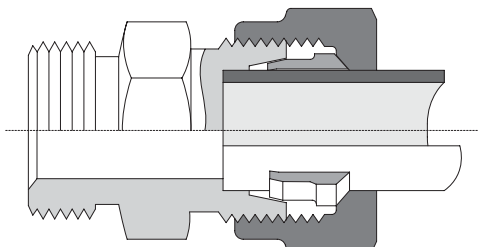
3.3. ASSEMBLY OF PLUG CONNECTIONS

3.3.1. Plug connections for steel tube

For tubes with an outside diameter up to 10 mm it is recommended to screw the relevant sockets of the plug connections into the respective devices, and to carry out assembly of the piping on the installation site.

The prepared end of tube with union nut and cutting ring is plugged directly into the threaded socket and the union nut is done up by hand to the tangible stop on the cutting ring.

before tightening of union nut

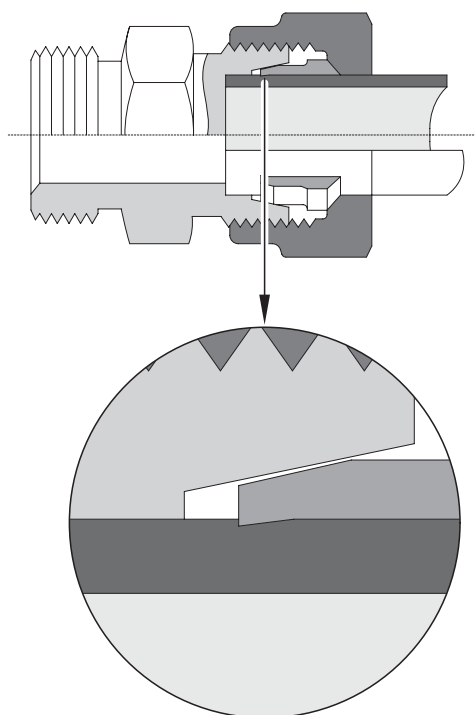


Now press the tube against the stop in the threaded socket, and tighten the union nut for approx. one $\frac{3}{4}$ turn. In the course of this, the tube must not turn. Since the cutting ring has now picked up the tube, a further pressing of the tube is unnecessary. Final tightening is done by repeated screwing down of the union nut for approx. 1 turn. After this, disengage the union nut and check if the cutting ring's edge has penetrated the outer skin of the tube and if the collar in front of the edge is visible.

If necessary, the union nut is to be tightened once again. It is insignificant if the cutting ring at the end of tube can be turned.

After completion of the connection as well as after any loosening, tighten the union nut by means of a standard wrench, without increased expenditure of energy.

after tightening of union nut



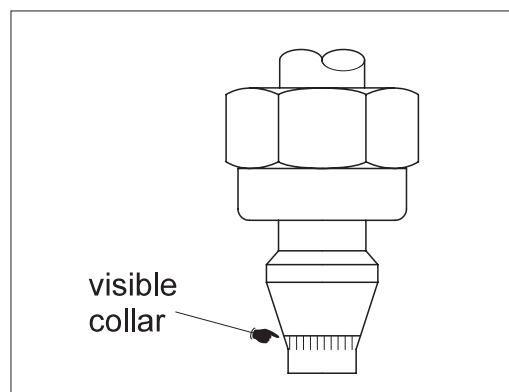
3.3.2. Plug connection for plastic tube

For tubes with an outside diameter up to 10 mm it is recommended to screw the relevant sockets of the plug connections into the respective devices, and to carry out assembly of the piping on the installation site. The end of tube with socket and union nut is done up by hand to the tangible stop on the cutting ring.

Now press the tube against the stop in the threaded socket and tighten the union nut with the torque specified. In the course of this, the tube must not turn.

3.3.4. Checking of Plug Connections

After having tightened the union nut, unscrew it again and check if the cutting edge of the cutting ring has penetrated the outer skin of the tube and if the elevated collar in front of the edge is visible.

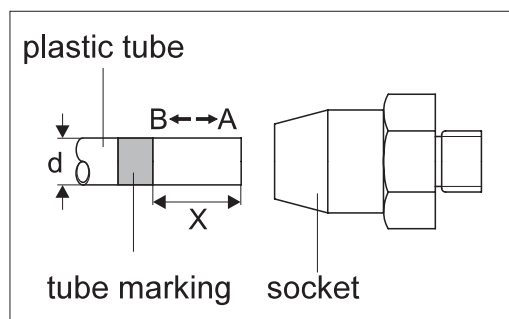


3.3.5. Assembly of Raufoss Plug Systems

ATTENTION: FOR SAFETY REASONS, SOCKETS MUST NOT BE DISMANTLED.

Before insertion, mark the plastic tube at gape "x", depending on its diameter, and then push it into the socket up to this mark. Afterwards check clamping of the plastic tube by a quick traction in direction "B".

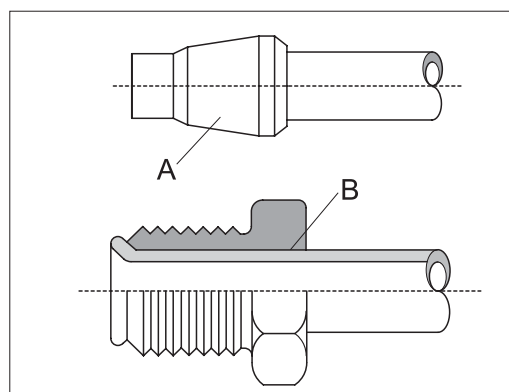
NOTE: THE PLASTIC TUBE MUST NOT TURN IN THE SOCKET.



3.3.6. Sealing of Screwed Pipe Joints

Before assembly of the plug connections, thinly coat the outer side of the cutting ring with a "sealing agent for screwings" (A).

For screwed pipe joints of hydraulic piping, coat the point of contact tube : screwed pipe joint with "standard grease" (B).

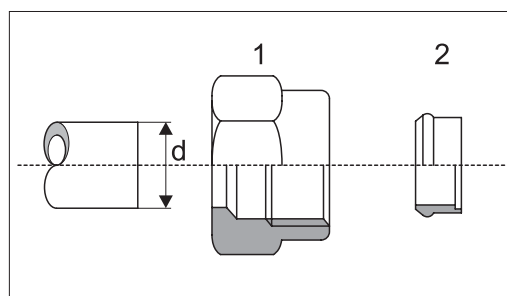


ATTENTION: GREASE AND SEALING AGENTS MUST NOT ENTER INTO PIPING

3.3.7. Tightening Torques

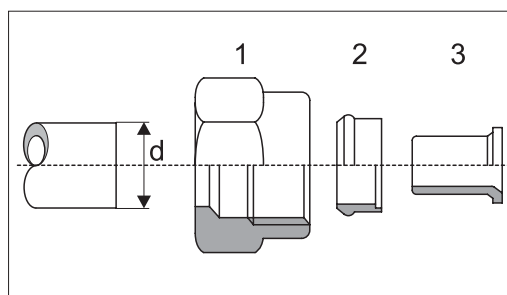
cutting ring connections for steel tubes:

Tube	Torque
6	10 - 12 Nm
18	65 - 80 Nm



cutting ring connections for plastic tubes:

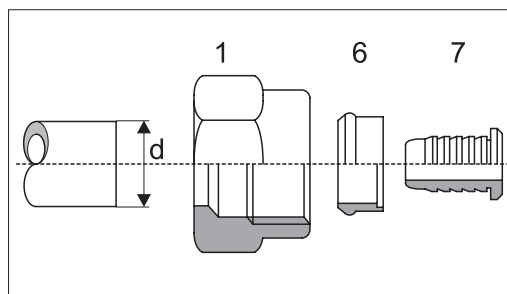
Tube	Torque
6	16 - 20 Nm
8	25 - 30 Nm



ATTENTION: ABSOLUTELY USE SLIP-ON SLEEVES!

clamping ring connections for plastic tubes:

Tube	Torque
12	30 - 50 Nm



screwed pipe-joints in aluminum housings:

Thread	Torque
M 10x1	20 Nm
M 12x1,5	26 Nm
M 14x1,5	28 Nm
M 16x1,5	35 Nm
M18x1,5	38 Nm
M22x1,5	40 Nm
M26x1,5	50 Nm

3.3.8. Pipe Relaying

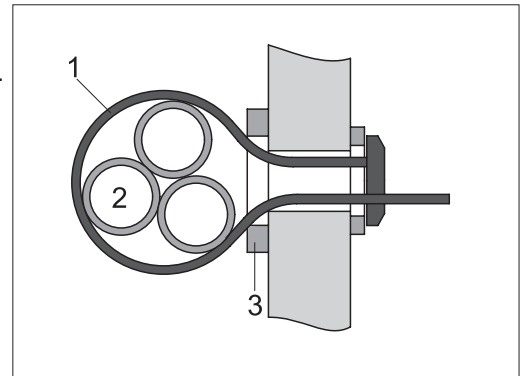
During assembly of pipings, take care of a non-chafing and, for plastic tubes, even of a non-twisting relaying.

Grooves or other damages of the tube surface are to be avoided. Damaged tubes are to be exchanged.

If plastic tubes are clamped with cable bond, it is to be ensured that the tubes are not constricted.

Relaying is to be done with sufficient safety distance to chafe marks.

In case of possible chafing, use an edge protection or a spacer.



3.4. TIGHTENING TORQUES

The values in this table refer to industrial standards and are to be applied in case of no indication of specific tightening torques.

For studs, the tightening torques are to be reduced for 50 %.

μ total *)	0,100			μ total	0,125			μ total	0,140		
grade of strength	MA in Nm			grade of strength	MA in NM			grade of strength	MA in NM		
	8,8	10,9	12,9		8,8	10,9	12,9		8,8	10,9	2,9
nominal Ø	metric control thread			nominal Ø	metric control thread			nominal Ø	metric control thread		
M 4	2,4	3,3	4	M 4	2,7	3,88	4,6	M 4	2,9	4,1	4,9
M 5	4,9	7	8	M 5	5,5	8	9,5	M 5	6	8,5	10
M 6	8	12	14	M 6	9,5	13	16	M 6	10	14	17
(M 7)	13	19	23	(M 7)	15	22	26	(M 7)	16	23	28
M 8	20	28	34	M 8	23	32	39	M 8	25	35	41
M 10	40	56	67	M 10	46	64	77	M 10	49	69	83
M 12	69	98	115	M 12	80	110	135	M 12	86	120	145
M 14	110	155	185	M 14	125	180	215	M 14	135	190	230
M 16	170	240	285	M 16	195	275	330	M 16	210	295	355
M 18	235	330	395	M 18	270	390	455	M 18	290	405	485
M 20	330	465	560	M 20	385	540	650	M 20	410	580	690
M 22	445	620	750	M 22	510	720	870	M 22	550	780	930
M 24	570	800	960	M 24	660	930	1100	M 24	710	1000	1200
M 27	840	1200	1400	M 27	980	1400	1650	M 27	1050	1500	1800
M 30	1150	1600	1950	M 30	1350	1850	2250	M 30	1450	2000	2400
nominal Ø	metric control thread			nominal Ø	metric control thread			nominal Ø	metric control thread		
M 8x1	22	30	36	M 8x1	25	35	42	M 8x1	27	38	45
M 10x1,25	42	59	71	M 10 x 1,25	49	68	82	M 10x1,25	52	73	88
M 12x1,25	76	105	130	M 12x1,25	88	125	150	M 12x1,25	95	135	160
M 12x1,5	72	100	120	M 12x1,5	83	115	140	M 12x1,5	90	125	150
M 14x1,5	120	165	200	M 14x1,5	140	195	235	M 14x1,5	150	210	250
M 16x1,5	180	250	300	M 16x1,5	210	295	350	M 16x1,5	225	315	380
M 18x1,5	260	365	435	M 18x1,5	305	425	510	M 18x1,5	325	460	550
M 20x1,5	360	510	610	M 20x1,5	425	600	720	M 20x1,5	460	640	770
M 22x1,5	480	680	810	M 22x1,5	570	800	960	M 22x1,5	610	860	1050
M 24x2	610	860	1050	M 24x2	720	1000	1200	M 24x2	780	1100	1300
M 27x2	900	1250	1500	M 27x2	1050	1500	1800	M 27x2	1150	1600	1950
M 30x2	1250	1750	2100	M 30x2	1450	2050	2500	M 30x2	1600	2250	2700

If the tightening torque of a screw connection is not achieved, the strength of the screw / nut is insufficient or the ratio of friction does not correspond. In any of these cases, the screw / nut is to be exchanged

*) μ total = total friction coefficient

3.5. CHECKING OF TORQUE WRENCH

The torque wrench requires regular checking as to the values adjusted. For signaling torque wrenches the release value is tested, and for measuring torque wrenches the scale accuracy .

3.6. NONDESTRUCTIVE TESTING OF MATERIALS

To detect and locate surface cracks, nondestructive testing based on the colour penetration testing process is recommended.

In this case, the workpiece is sprayed or coated with a penetrating agent, and after drying a developer is sprayed on. After a development period of approx. 10 min., defects on the workpiece appear as points or lines.

3.7. USE OF ADHESIVE AND SEALING MATERIALS

The workshop manual names adhesive and sealing materials for the repair of engines and aggregates, which may be used at operating temperatures up to 150°C and with mediums such as water, cooling and hydraulic liquids, engine and transmission lubricants as well as fuels.

Solvent free sealing material

Hardening without loss in volume; tightening of screw joints hence not required.

Anaerobic sealing materials

are used for securing, fixing and sealing, and will only harden with exclusion of air.

Sealing material containing solvent

Their volatile ingredients will cause a loss of volume during hardening. For repair works, their exhaust period is to be considered. If such sealing material is used, the workshop manual will contain a particular reference.

3.8. SOLVENT FREE SEALING MATERIALS

Silicon sealing materials

consist of silicon and fillers, and are solvent-free.

From the tube or cartridge, the product is applied in a straight line on the cleaned surface. Residues of sealing material are removed by means of cleaning agent.

Silicon sealing material is to be stored at temperatures below 30° C.

Anaerobic sealing materials

consist of single-component synthetic in fluid form. The product is applied on the assembly parts and remains fluid as long as it is in touch with the ambient air (oxygen). Only as soon as the parts are assembled, the chemical reaction, the transformation of fluid into a synthetic built up by molecular chains, begins through exclusion of atmospheric oxygen and through metal contact.

Any surplus remaining after assembly or being forced out of the connection remains fluid and can be removed easily.

3.8.1. General Directions for Use of Anaerobic Sealing Materials

Cleanliness of components

Non-metallic surface protection must be removed. In case of repair works, soiled and oily components are to be cleaned and residues of adhesive synthetic are to be removed. Tapholes are recut with an appropriate tap and blown off with compressed air.

If solvents or degreasing agents are used for cleaning, make sure that they have volatilized before application of the synthetic.

Storage

At temperatures below 28° C, 1 year minimum.

Directions for securing (S)

Indication: SM Medium-tight Securing (the connection can be loosened without problems)

Indication: SF Tight Securing (the connection is difficult to loosen)

Application: Screw joints

Fixing procedure

In general, it is sufficient to apply the synthetic on the screw thread.

If screws are screwed into socket threads, only wet the taphole in order to let the air escape during screwing. Screws or nuts to be tightened with a specified torque are slightly oiled on their contact surface or housing section.

Directions for fixing (B)

Indication: BM Medium-tight Fixing

Indication: BF Tight Fixing

Application: Joint connections, sleeves, gear wheels, pulleys, bearings etc.

Jointing procedure

For jointing connections, both jointing parts are to be wetted. Wetting should completely cover the jointing surfaces. In case of sliding fits, the parts are encased by turning.

No strength may be exerted to the connection until sturdiness is reached (for duration see table 1).

Directions for sealing (D)

Indication: DR Sealing of pipe joint connections

Indication: DF Sealing of plane surfaces

Application: Sealing of threads, screwings, joint connections and plane surfaces.

Hardening time

Use	Securing		Fixing (B)	Sealing		
Class	SM	SF	BF	DR	DF	DF
Product	Loctite 243	Loctite 262	Loctite 648	Loctite 572	Loctite 510	Loctite 620
Handtightness reached after	15 - 30 min	15 - 30 min	5 - 10 min	15 - 30 min	immediately	immediately
Functional tightness reached after	1 h	1 h	1 h	0.5 h	immediately	immediately
Final tightness reached after	3 h	3 h	4 h	12 - 24 h	24 h	12 - 24 h

4. VARIANTS ENGINE - PROPULSION

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4.1. VERSIONS FOR 6 CYL. MARINE ENGINES	3
4.2. VERSIONS FOR 4 CYL. MARINE ENGINES	6

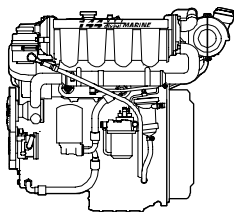
4. VARIANTS ENGINE - PROPULSION

NOTES

4. VARIANTS ENGINE - PROPULSION

4.1. VERSIONS FOR 4 CYL. MARINE ENGINES

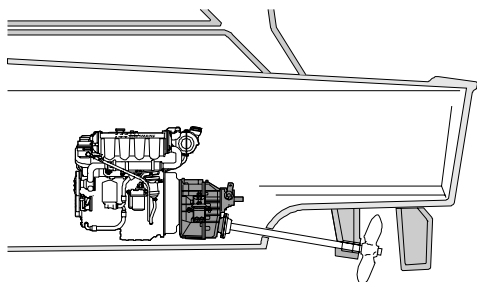
Bobtail - Version



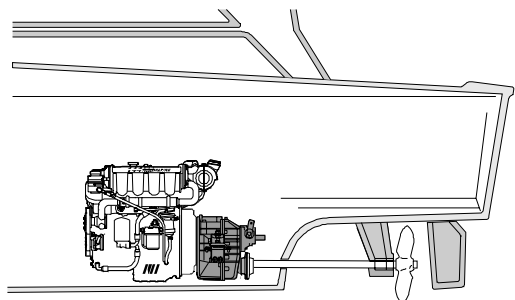
Equipment
with side mounted raw water
pump
with side mounted raw water
pump, power steering pump

Inborder i.e. ZF 45 Marinegear

Down angle

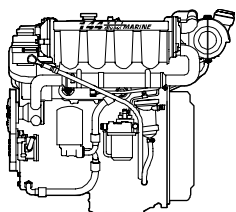


Innenborder i.e. ZF 63 Marinegear



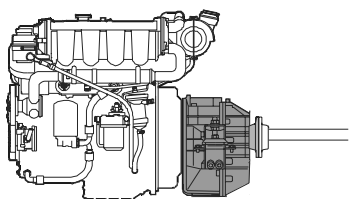
For exact installation dimensions, see chapter 17 "Drill templates"

Lifeboat Engine

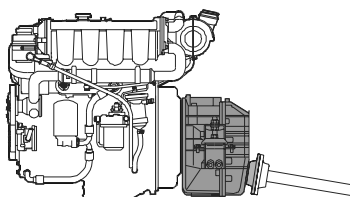


Equipment

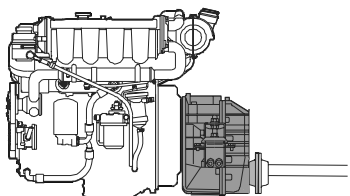
Bobtail "B"



Direkt gearbox



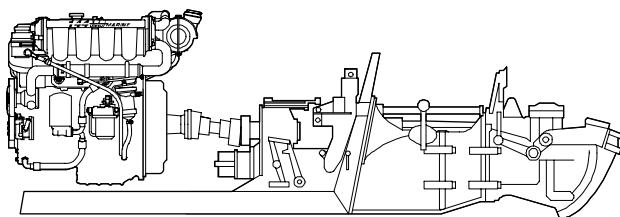
A-down angle gear box



Parallel offset gearbox

For exact installation dimensions, see chapter 17 "Drill templates"

Jet Drive

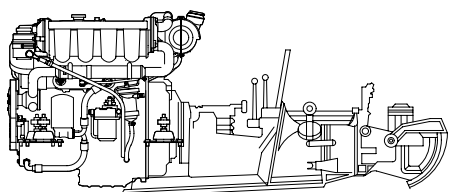
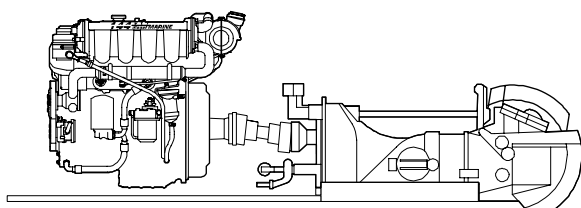


TYPE

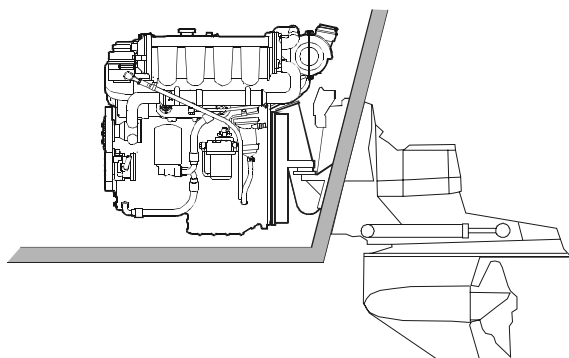
Alamarin

Hamilton

Castoldi



Stern Drive



TYPE

Mercury Alpha Bravo I, II & III

Volvo DP 290

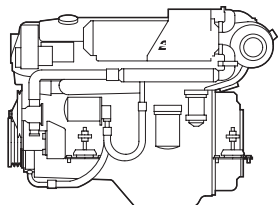
Volvo DP 290 Hydraulic

SX - Stern Drive

For exact installation dimensions, see chapter 17 "Drill templates"

4.2. VERSIONS FOR 6 CYL. MARINE ENGINES

Bobtail - Version



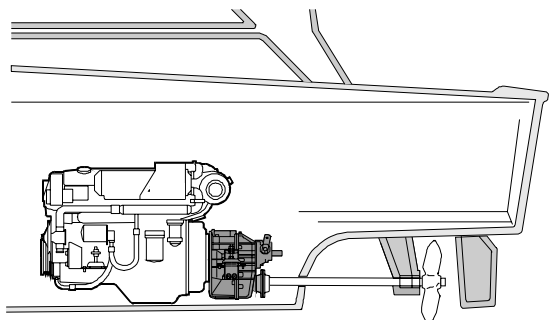
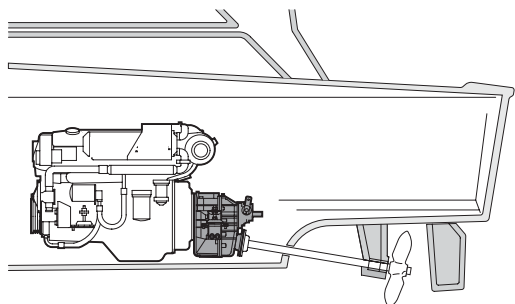
Equipment

with side mounted raw water pump

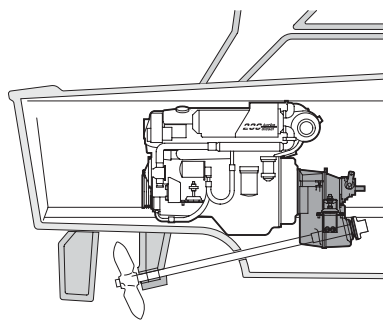
with side mounted raw water pump, power steering pump and front mounted auxiliary drive-PTO

Inborder i.e. ZF 63 Marine gear

Down angle



For exact installation dimensions, see chapter 17 "Drill templates"



Transmission

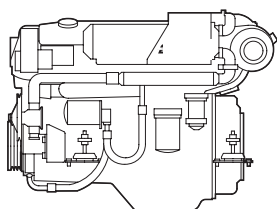
$i = 2.5V$, shaft angle 12°

$i = 2.0V$, shaft angle 12°

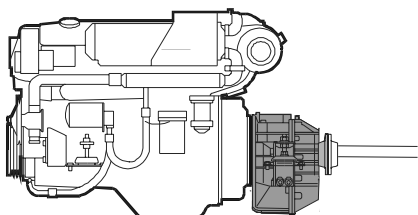
Lifeboat Engine

Equipment

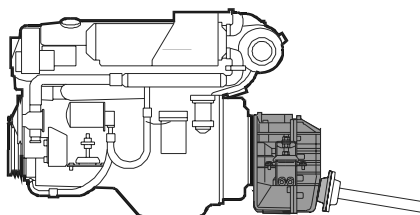
Bobtail "B"



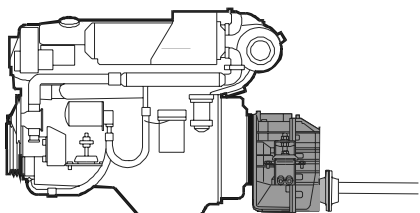
Direkt gearbox



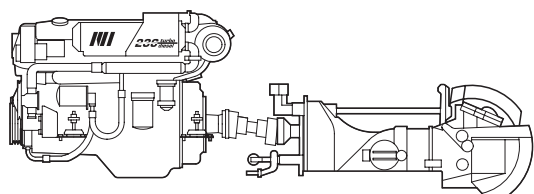
A-down angle gear box



Parallel offset gearbox

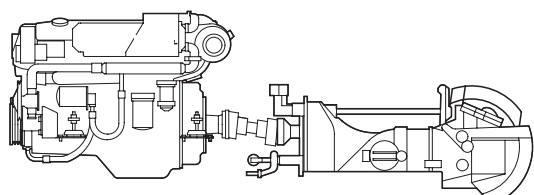


For exact installation dimensions, see chapter 17 "Drill templates"



Jet drive

Jet Drive

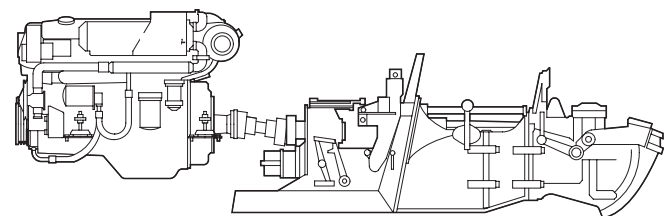


TYPE

Alamarin

Hamilton

Castoldi



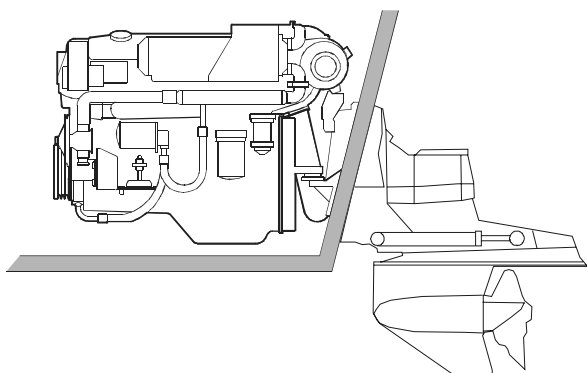
Stern drive

Type

Mercury Bravo II & III

Volvo DP 290

Stern Power Drive

Volvo DP 290 ZF
Hydraulic PumpVolvo SX - Drive
King Cobra Drive

For exact installation dimensions, see chapter 17 "Drill templates"

5. ENGINE INSTALLATION

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5. ENGINE INSTALLATION

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5. ENGINE INSTALLATION

After pre-planning, assembly of the engine usually begins with the engine base. Then the stem bearings, if available, the step- or thrust bearing and the propeller shaft are mounted. After that, the fuel tanks, the water tanks with control device and the battery box are installed.

The engine is attached to the base and aligned in relation to the propeller shaft. Then the exhaust pipes, the air pipe to the engine, the aeration pipes and the sound-absorbing material for the engine compartment are mounted. Manoeuvring apparatus, instruments and electrical equipment are installed last.

After the final trial run, a precise check with final inspection is to be carried out. Test results to be noted.

5.1. FOUNDATION

The individual aggregates and parts of the marine propulsion unit must be aligned precisely to each other, in order to guarantee a troublefree operation. The distortion rigidity of the foundation should thus be to such an extent that ship distortions due to motion of the sea or loading resp. unloading of the ship are not transmitted onto the propulsion unit. In addition, the foundation must absorb the propeller thrust of the thrust bearing and transmit it onto the hull.

The foundation's supporting surface for the propulsion unit should be for approx. 3/8 - 13/16" (10 - 20 mm) under the nominal size in order to permit, during assembly and alignment of the unit, the balancing of unevenness and differences by means of fitting pieces. All fitting pieces should be of the same material, e.g. steel or cast steel. Soft material, e.g. copper, must not be used for fitting pieces and shims.

For boats made of wood or synthetics as well as for ships not built for a self-contained propulsion or where a considerably stronger unit should be installed, it may be useful to attach a subframe for reinforcement of the foundation.

5.2. POWER TRANSMISSION

5.2.1. Coupling

For power transmission from the engine to the gear we recommend a turn-elastic coupling. In all other cases of suspension of engine and gear, a turn- and radial elastic or an articulated coupling with torsion spring plate is required between engine and gear. Coupling size depends on the maximum engine torque to be transmitted, the torque peaks due to the degree of irregularity of the engine, and the alternating moments of torsional vibration at critical speeds of the boat. Based on a torsional-vibration computation it must be checked whether the chosen coupling as well as dimensioning and arrangement of the unit could lead to undue torsional vibrations causing severe damages.

For couplings using rubber as spring elements and for power transmission, it is to be considered that the transferable alternating moment of oscillation decreases very fast with increasing temperature of the rubber. Based on the information of a known manufacturer of elastic couplings, the temperature factor at 60°C is 1, and at 80°C 0,5 only. Therefore an effective aeration of the coupling is useful since the rubber expands or contracts with ambient temperature.

For assembly of the clutch and alignment of the coupling flanges, the manufacturer's instructions are to be considered.

When assembling a coupling, or a connecting shaft between engine and gear, or when flanging a gear, the end clearance of the engine's crankshaft must not be affected. V-belts, gear couplings or similar connecting links thus should permit to be engaged easily. Also when flanging a gear onto the engine, make sure that after tightening of the fastening screws no axial load or tension is transmitted onto the crankshaft. It is, therefore, necessary to check the end clearance of the crankshaft journal before and after assembly. During both checks, the clearance must be equal. The crankshaft must not spring back after pressing it against the front and rear collar of the lapped bearing.

On boats destined for frequent reversing and maneuvering, e.g. service boats, the couplings are heavily stressed by start-up impacts and acceleration. For this reason, a larger coupling should be chosen. In addition, it should be considered not to drive too long at the critical speed range.

If a disconnectable coupling is used, the admissible axial load of the crankshaft must not be exceeded.

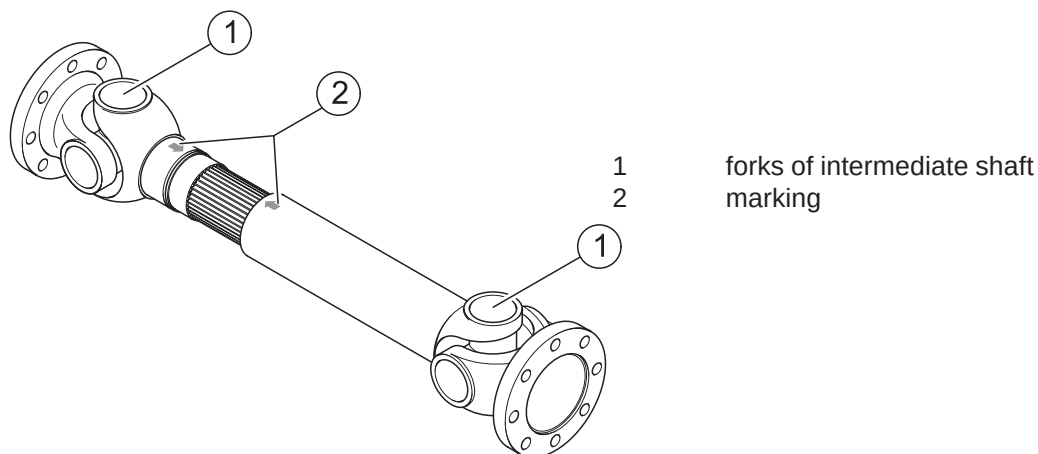
5.2.2. Universal-Joint Shafts

Principles:

A universal joint produces a more or less strong irregularity on the driving axle, depending on the diffraction angle. This irregularity is compensated by providing a second universal joint, under the following conditions:

1. The two forks of the intermediate part must be coplanar.
2. The diffraction angle of the second joint must be of the same size as that of the first one; both joints must be coplanar.

ill. 5/1



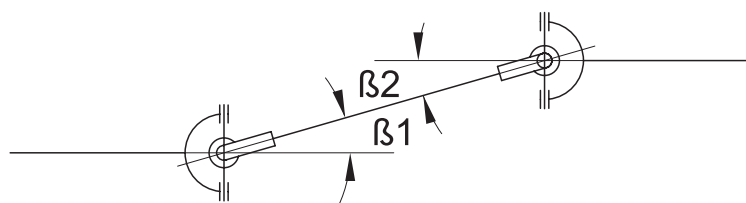
The illustration shows how the two forks of the intermediate shaft should be positioned to each other (acc. to 1. - coplanar). The splined shaft ends mostly show index arrows which should be opposite when connecting the shaft.

The following illustration shows the Z- layout of a universal-joint shaft.

The two angles β_1 and β_2 must be equal. This means that with Z- design the contact faces of the shaft ends for drive and drift must be parallel to each other.

IMPORTANT: diffraction angle $\beta_{\min} = 1^\circ$, $\beta_{\max} = 6^\circ$

ill. 5/2



Slight deviations from these requirements are admissible under certain conditions; to what extent depends on the application, the speed, the diffraction angle etc.

Depending on the diffraction angle of the two universal joints of a shaft, the intermediate shaft will be more or less accelerated or retarded with every rotation. This causes a stimulation of oscillation which is to be considered for the location of the universal-joint shaft between engine and gear. Overhanging mass on the shaft end at the flywheel side, such as e.g. couplings, may be critical.

Considering the additionally occurring bending moment which depends on the initiated torque, the length of individual universal-joint shafts cannot be chosen at random. If necessary, several universal-joints shafts are to be arranged.

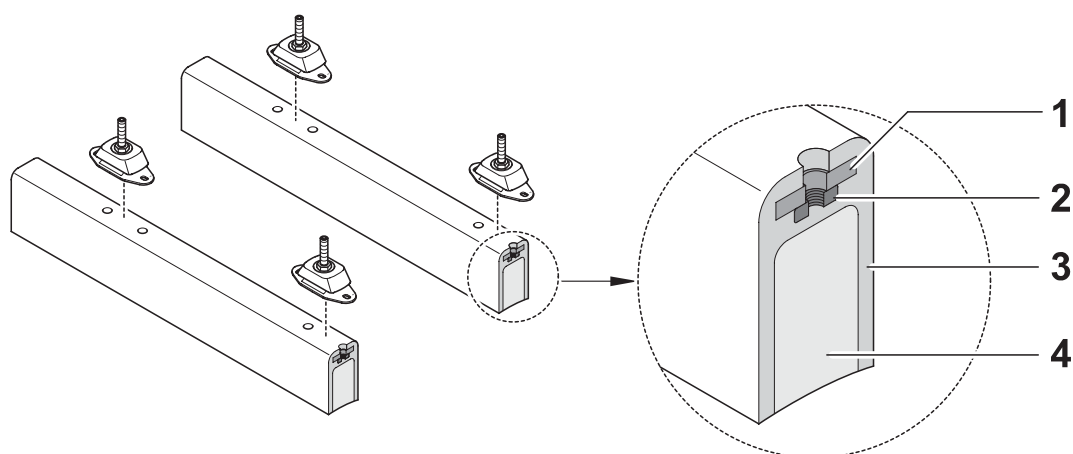
5.3. ENGINE BASE

The engine base should be of a very rigid design. Its suspension is to be distributed on the maximum surface over the ship bottom. The engine base should be strong enough to absorb with free play the compressive- and shearing forces of the propeller. Strains through heavy sea and dynamic load are also to be considered.

5.3.1. Engine base on synthetic boats

On synthetic boats, the engine base may be made of flat irons (see ill. 3) casted in the boat. The base (3) should be constructed as a box, and filled with damp-proof material (4).

The flat irons (1) should be long enough to distribute the load of the engine over a surface as large as possible. To facilitate screwing of the engine mounts, nuts (2) can also be cast .

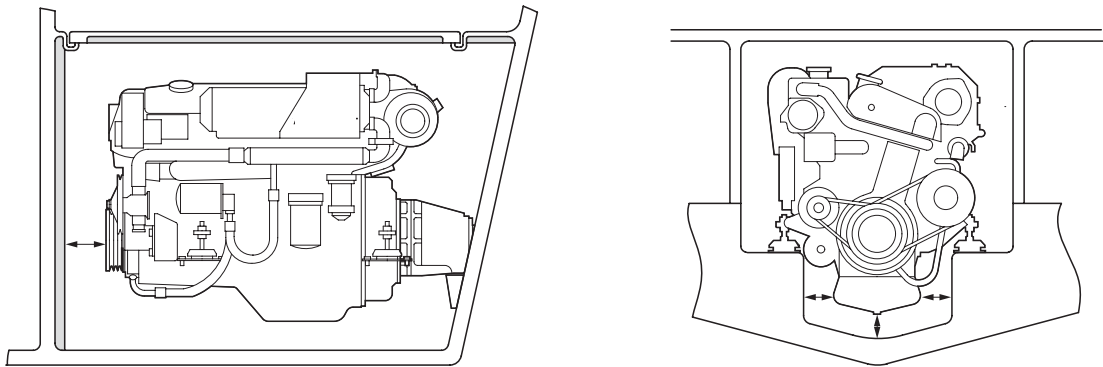


ill. 5/3

5.4. SPACE FOR MAINTENANCE

The engine compartment is to be designed in such a way that maintenance work will not be impaired by bottom plates or other equipments. Compare these requirements to the maintenance chart in the operating manual. Also take care that there is enough space for lifting and lowering the engine.

Before beginning the assembly, make sure that scale drawings for the engine and its equipment are available (see appendix). All necessary dimensions for assembly follow from the scale drawings, e.g. the distance from the crankshaft centre to the engine bearers (reversing gear bearers) and to the centre line of the propeller shaft.



ill. 5/4

IMPORTANT: Keep sufficient distance between base frame, oil pan and starter motor (< 3/4" / < 20 mm).

5.5. ENGINE INCLINATION

Max. permissible engine inclination (backwards in direction of flywheel) corresponds to angle A, see table. The engine must not be inclined downward in direction of the heat exchanger, since such an installation could affect the cooling due to remaining air pockets.

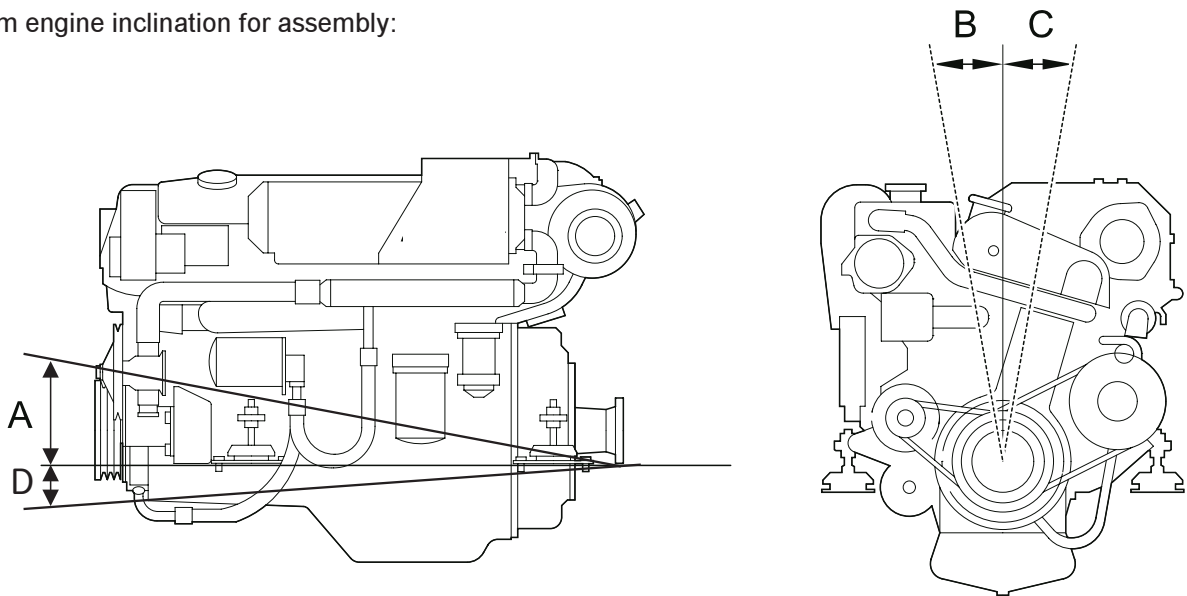
When installing the engine with the flywheel side in direction of the bow, the inclination in direction of the flywheel should be 3° at least.

Such an installation with inverted engine occurs with a miter gear.

During course, A may be up to 3° larger and B up to 3° smaller (the stern is lower).

Maximum engine inclination for assembly:

ill. 5/5

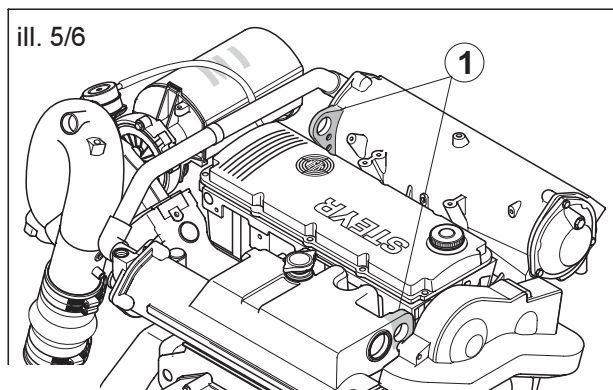


max. inclination in °	4 & 6 Cyl.
A	10°
B	10°
C	10°
D	5°

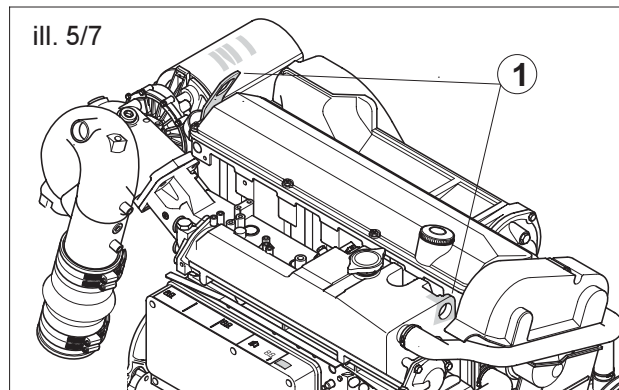
5.6. LIFTING EYES

To permit an easy lifting of the engine, strong lifting eyes are provided bow- and stern-sided. See ill. 5/6 u.5/7.

4 Cyl. Engine



6 Cyl. Engine



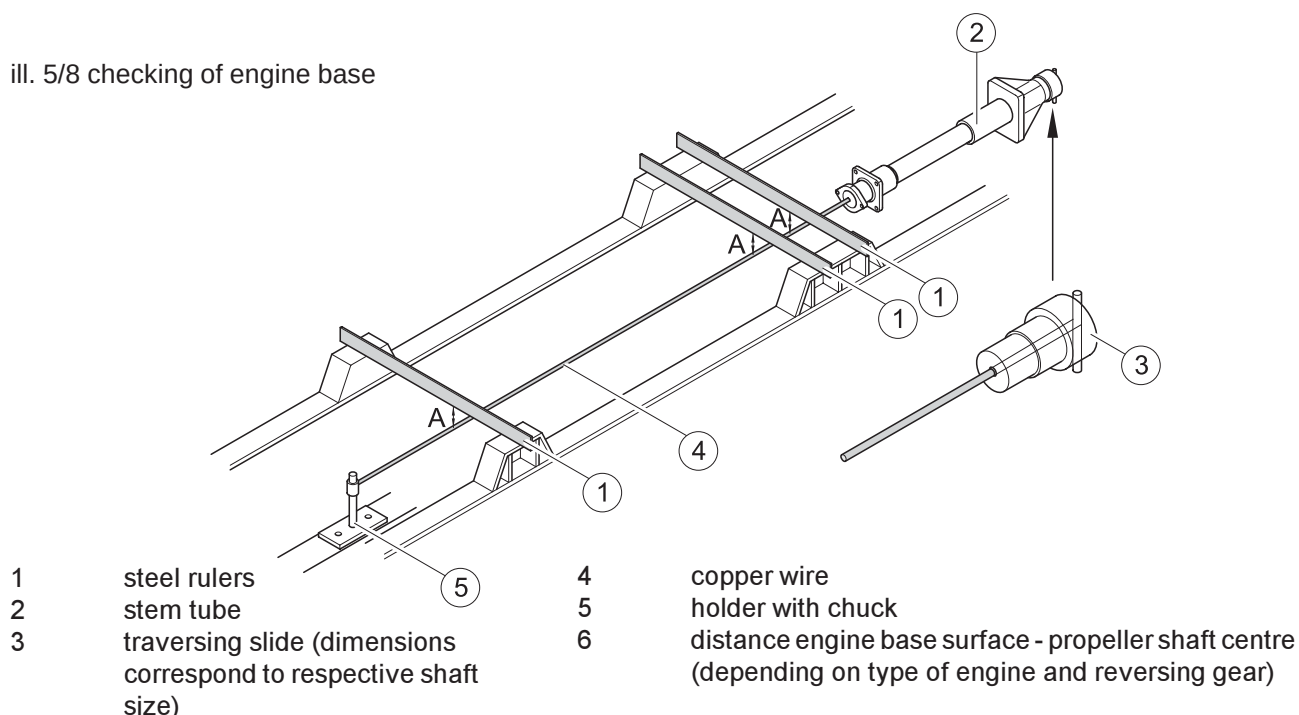
ATTENTION: NEVER PLACE THE ENGINE DIRECTLY ONTO THE FLOOR. THE OIL PAN AND OTHER PARTS COULD BE DAMAGED. JACK UP THE ENGINE ON THE ENGINE BEARERS SO THAT ITS LOWER PART IS TRAILING, OR KEEP THE ENGINE IN THE TRANSPORT BOX UNTIL IT IS LIFTED INTO THE BOAT.

Do not lift the engine from any single lifting point, damage to the engine or personnel injury could accrue. When having to tilt the engines for installation use an adjustable load leveler to aid in installation.

5.7. CHECKING OF ENGINE BASE

When preparing the engine base, make sure that the upper contact surfaces of the bearers are parallel to the centre line of the propeller shafts and are not swung. For assistance during assembly and checking of the engine base, a short traversing slide with the same diameter as the propeller shaft may be used stern-sided; see ill. 5/8. Through a bore (1/12" / 2mm diameter) in the slide a 1/12" (2 mm) copper wire is strained to a holder. Then adjust the holder in such a way that the wire is in the centre of the front end of the propeller shaft sleeve. Then measure the base bearers and check their correct height and that they are not swung.

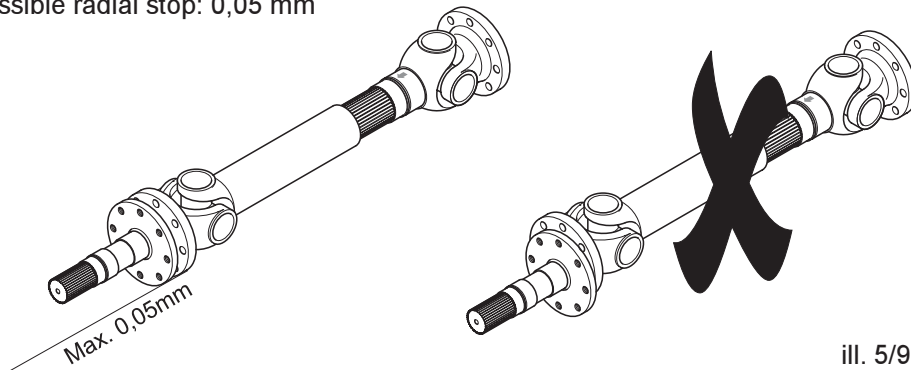
ill. 5/8 checking of engine base



5.8. PROPELLER SHAFT FLANGE

At delivery, the flange to the reversing gear is rough-drilled only. The bores are to be made with utmost accuracy and have to correspond to the guiding edge on the flange.

Max. admissible radial stop: 0,05 mm

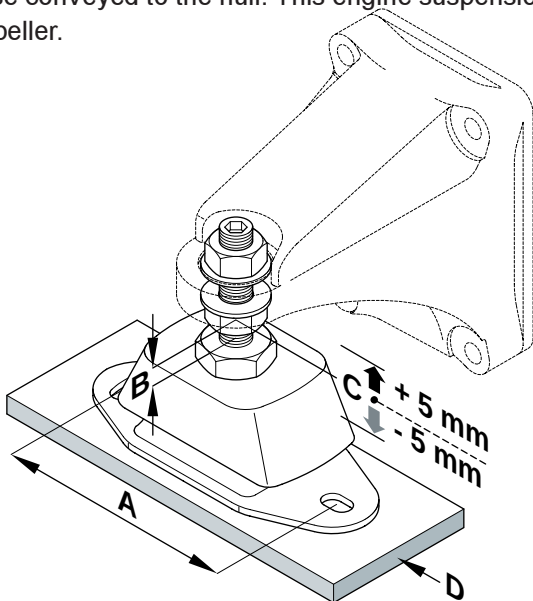


ill. 5/9

In many cases it is recommended to bore the coupling flange to the reversing gear with the same conicity as for the propeller. Thus the shaft will be equal on both ends and can, therefore, be turned in case of being worn out in the stem bearing.

5.9. ENGINE MOUNTS

The flexible engine mounts provide proper insulation between engine and base frame, thus reducing the noise conveyed to the hull. This engine suspension may also absorb the thrust and shearing forces of the propeller.



For all STEYR Marine Engine

ill. 5/10

- A bore dim. bearing flange
- B position of adjustment nut (~ 5 mm)
- C adjustment space (+/- 5 mm)
- D spacer plate (if required)

Install the engine mounts directly onto the member of the base frame see ill. 5/3

For an assembly with flexible engine mounts the overall height of the engine mounts is to be considered to achieve the proper installation height of the engine. Height Adjustment recommended to achieve accurate alignment of the suspended unit.

When fitting mounts with height adjusters, care must be taken to ensure that excessive bending forces are not imposed on the center spindle (screw). Mountings fitted with height adjusters are designed to allow a variation of ± 5 mm on nominal mean height (see illustration 5 mm distance between adjustment nuts). Any larger variations need to be accommodated by fitting shims or packers under the mounting base. Vertical and horizontal alignment should then be effected using the height adjusters and slotted holes in the mounting base. Recheck alignment after fixings are tightened to the specified torque values (nut center spindle screw 110 – 120 Nm).

5. 9. 1. Adjustment of Engine on flexible engine mounts

The settings of the height adjusters should be equal right and left. Between the front and rear of the engine a difference in adjustment is admissible and often unavoidable. Before beginning the alignment the engine should rest on the mounts for about 48 hours.

Proper setting of the engine mounts can be done as follows:

Roughly align the engine with the propeller shaft on the mounts by means of adjusting nuts, without connecting the propeller shaft to the flange on the reversing gear.

Lift the engine at the front to such an extent that both front supports are released from the lower nuts of the mounts.

Lower the engine and adjust the nuts so that both engine supports sit simultaneously. Same procedure at the rear side of the engine.

The engine foundation must be rigid enough to absorb the concentrated load. After correct adjustment of the engine mounts, the engine can be balanced by front and rear adjustment of the two nuts right and left with exactly the same number of turns.

In longitudinal direction, the vibration dampers are to be mounted free of tension.

Engine mounts being mounted with initial stress may transmit vibrations and sound into the hull.

The oblong holes in the vibration damper feet permit a lateral correction of the adjustment. When the boat is in the water, the alignment is to be checked once again.

5. 10. ELASTIC SHAFT COUPLING

For engines with elastic suspension and a rigid stem bushing, an elastic shaft coupling is always to be mounted. Even for a rigid engine suspension, an elastic propeller shaft coupling should be mounted if there is any risk that the engine may change its position with regard to the propeller shaft, e.g. with different load of the boat. Never use the elastic shaft coupling together with the elastically supported stem bushing. This may result in heavy vibrations. Elastic engine suspension and elastically supported shaft bushing may, however, be used without elastic coupling.

Engines provided for operation under heavy conditions, e.g. way through ice, are always to be equipped with elastic propeller shaft coupling. A special thrust bearing for the propeller shaft is also to be mounted. The elastic coupling should be situated between reversing gear and thrust bearing, to avoid tensions between the parts.

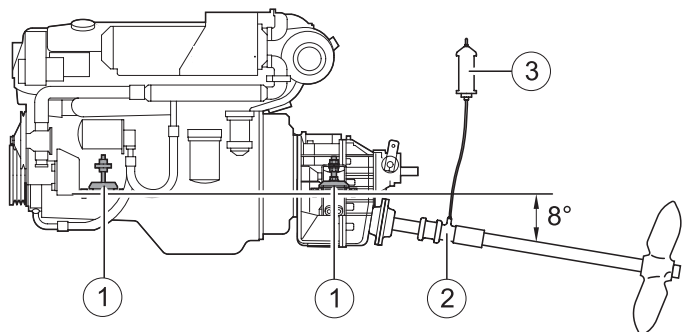
5.11. STEP BEARING

If the distance between the supports (a in ill. 12 and 13) exceeds 6 1/2 ft (2 m), a step bearing is to be mounted. The correct distance between the step bearing and the engine is of utmost importance, which requires a computation of vibrations.

Examples:

Elastic engine suspension, elastic stem tube and bearing at 8° for reversing gear

- 1 elastic engine suspension
- 2 gland in rubber suspension
- 3 grease gun



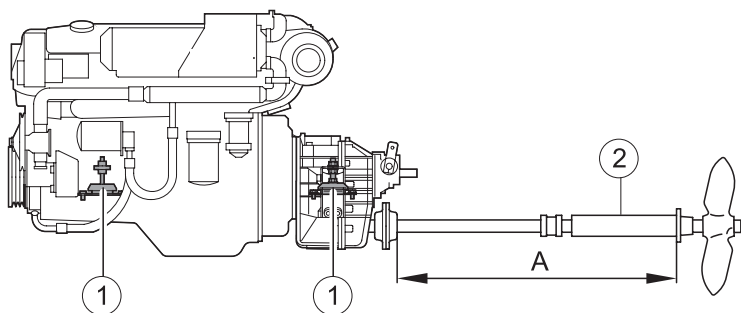
ill. 5/11

Engine with elastic suspension and fixed stem bearing

- 1 elastic engine suspension
- 2 elastic shaft coupling
- 3 butt-supported stem bearing

Attention: The stem bearing must not be elastic.

A max. distance between supports
6 1/2 ft (2 m)



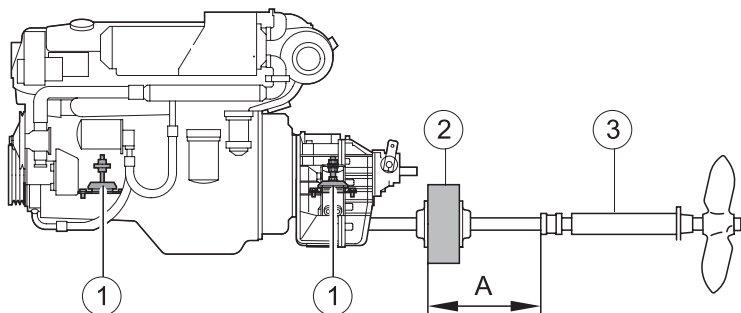
ill. 5/12

Engine with elastic suspension and elastically supported stem bearing

- 1 elastic engine suspension
- 2 elastically supported stem bearing

Attention: The shaft coupling must not be elastic.

A max. distance between supports
6 1/2 ft (2 m)



ill. 5/13

5.12. ADJUSTMENT OF ENGINE DRIVE UNIT

As soon as the base frame has been finished, the propeller shaft mounted and the other preparation works done, the engine and the reversing gear can be mounted.

For engines with double reversing gears, the reversing gear is to be mounted first and exactly aligned to the propeller shaft. Then the couplings are mounted, and the engines are aligned towards the reversing gear.

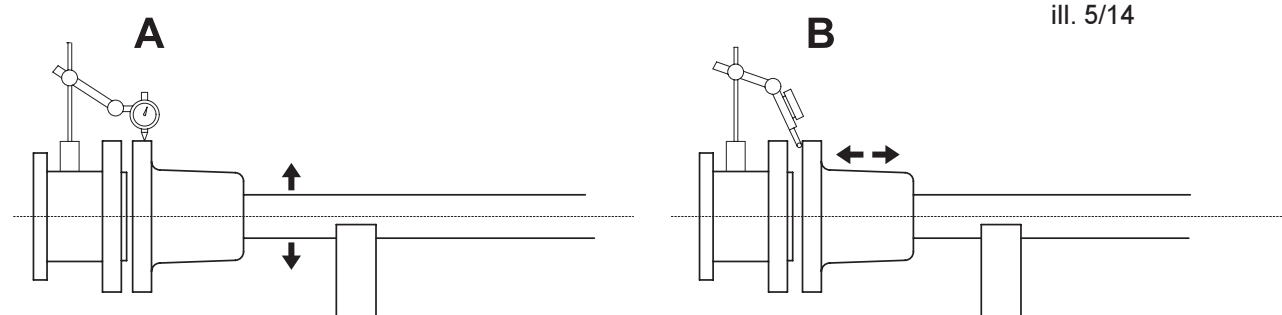
First adjustment of the engine on the boat can be done either on land or on the seas. Before final adjustment, the boat should, however, be on the seas for some days so that the body can take its final shape.

When mounting a marine reversing gear, it is recommended to check the parallelism of the flanges by means of a dial gauge.

In this case, the propeller shaft is to be moved sternwards for approx. 3/8" (10 mm) and be well supported so that the clearance in the stem tube is uniformly distributed (exactly center the shaft).

Rotate the reversing gear shaft and measure at first the radial off-size. Correct the position of the reversing gear. Then check the axial off-size by a hinge dial gauge on the contact surfaces of the flange.

In both cases, max. possible off-size is 0,1mm.



A checking of radial off-size

- | | |
|---|----------------------------|
| 1 | dial gauge |
| 2 | flange on reversing gear |
| 3 | propeller shaft |
| 4 | support of propeller shaft |

A checking of axial off-size
(hinge dial gauge)

- | | |
|---|----------------------------|
| 1 | dial gauge |
| 2 | flange on reversing gear |
| 3 | propeller shaft |
| 4 | support of propeller shaft |

After having finished the adjustment, prepare supporting disks fitting between the engine-reversing gear bearers and the rests on the engine. Measure the distances and prepare steel disks to be ground to the dimensions found. Make all bores for the bearers, and screw on the engine and the reversing gear. Take care that all setscrews for the high position are unscrewed so that the bearers do not rest on the screws but on the supporting disks. After alignment, remove the setscrews for high position.

After launching the boat, check the adjustment once again. The boat with filled tanks and the required equipment should have been on the seas for some days. Ship bodies are elastic and do not have the same shape when they are propped up.

In case of a necessary readjustment, distance plates can be mounted under the bearers.

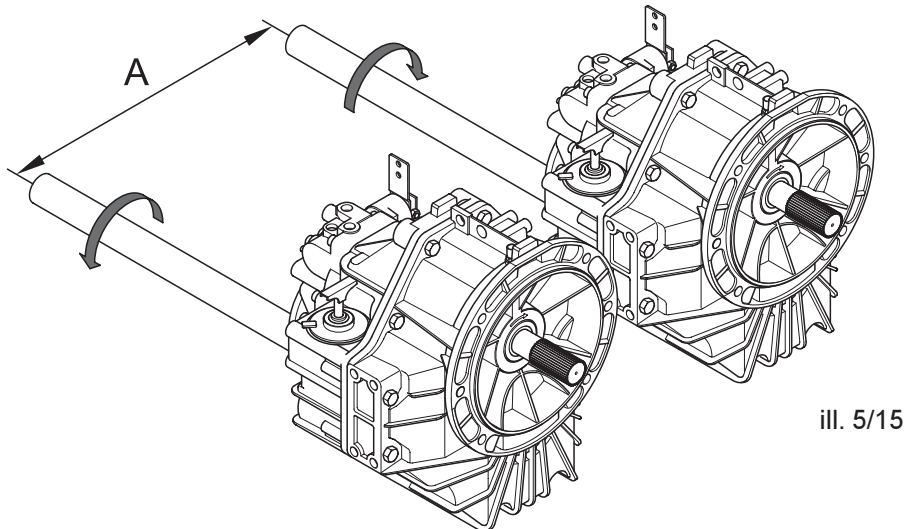
After start-up of the boat, verify at regular intervals that the adjustment of the machine unit has not changed due to deformations of the body.

A bad alignment of engine and propeller shaft may cause a lot of disturbances and operating troubles. Such troubles may also result in vibrations in the hull, in the reversing gear, and in a quick wear of the propeller shaft bearings, the shaft and the stem tube supports

.

5.13. TWIN INSTALLATION

When mounting engines with one propeller each, choose the reversing gears in such a way that the starboard propeller rotates clockwise and the port side propeller counterclockwise, seen in the direction of the bow.



ill. 5/15

centre distance of shafts A (min. dimension) approx.: > 31" (> 787 mm)

5. 14. SHAFT AND STEM TUBE

To choose the right components of engine, reversing gear and propeller with regard to the respective ratio of load, follow the recommendations as to power and speed of various engines, to be found in the product information "marine engines". The combination of reduction of speed, shaft diameter and propeller size may be computed based on our recommendations on propellers, included in a separate pamphlet. Computation and determination of the propeller size may also be done by STEYR Motorentechnik (claim in time, together with drawing). Consider a sufficient distance between propeller, hull, keel, stem tube and oar. To permit a dismantling of the reversing gear or the coupling, a sternward displacement of the propeller shaft for at least 8" (200 mm) should be possible. Also take care that no transept bulkheads do interfere with dismantling. Between propeller and stem bearing a min. distance of 1" (25 mm) is to be kept in order to prevent the propeller from bucking against the stem bearing. Before mounting the shaft, its straightness is to be controlled. Check by means of a dial gauge that the shaft flanges do not twist. Max. admissible axial fault 0,1 mm.

Before launching the boat, make sure that a propeller with correct pitch and diameter has been mounted. Also check that the propeller shows the correct thread (R or L) for the provided sense of rotation.

The exact alignment of the whole drive unit on the foundation is a condition for troublefree operation. On principle, assembly and alignment is done in the order driving shaft - engine. Flange connections and couplings (even elastic ones) must be released when aligning the parts connected. For elastic couplings follow the manufacturer's instructions.

For alignment of the parts to be mounted a dial gauge with suitable holder and eventually a thickness gauge will be necessary. Alignment always requires two checks:

vanishing check (contact accuracy) and
angularity check (no bends).

With two dial gauges, both checks can be done simultaneously.

For each check, the part at which the dial gauge is fixed is to be moved for at least one turn. An exact alignment of the part to be mounted mostly requires several checks. Because of that it is advisable to fix the dial gauge on that part which can be turned more easily.

5. 15. PROPELLER

Too less attention is paid to the propeller and in particular to its efficiency even though it is responsible for transformation of engine energy into mouvement. Sizing and selection of the propeller mean a positive or negative decision as to driving qualities as well as fuel consumption.

Voluminous books have been written about right sizing and computation of a propeller. For this reason, the following information shall serve for better understanding of the complexity and impart basic knowledge.

Of all driving possibilities developed so far, the propeller shows the best efficiency. Sizing of the propeller is determined by the boat type, the engine power and speed.

5. 15. 1. Dimensions

A propeller is designated by diameter, pitch, number of blades, blade surface, sense of rotation and hole in the hub.

Diameter of the propeller is determined by:

- a) engine power in horsepower or kilowatt-hours
- b) propeller speed (number of revolutions of engine divided through reduction of gear)
- c) speed of the boat.

It is a wrong assumption that the propeller determines the speed, but it is the combination of engine power with adapted hull and matching propeller.

The propeller diameter can be approximately computed based on the diagram enclosed, but this only for "water displacers". Before using the diagram, the max. speed of the ship is to be computed. Only use this diagram for an approximate computing of the diameter, e.g. for determining the height of the propeller frame. Computing of the correct diameter and of the pitch is to be done by a specialist. STEYR MOTORENTECHNIK offers this service to their dealers and customers. If required, please fill in the enclosed form.

5. 15. 2. Propeller pitch

The pitch is the theoretical distance the boat runs at one rotation of the propeller, which is being determined for 100 % by the speed of the boat. Every propeller rotating in water will have a slip. Thus the advance of the boat will be approx. 60 to 75 % per rotation of the pitch.

Computation of pitch:

$$\begin{aligned} \text{pitch} &= \frac{\text{speed (m/min)}}{\text{rotation of propeller}} \times \text{slip (\%)} \\ \text{pitch} &= \frac{300}{1200} \times 0,7 \text{ (30\% slip)} \\ \text{pitch} &= 0,357 \text{ m} \end{aligned}$$

A propeller the pitch of which is not exactly adapted to the speed of the boat, will always show a lower efficiency. To reduce the diameter and then increase the pitch for the same size, which sometimes is required when the actual diameter cannot be housed, will thus reduce the efficiency.

5.15.3. Blade Surface

Correct determination of the blade surface is also to be done by specialists. It depends on the speed and the type of boat, and is always indicated in relation F_a / F ; F being the total area of the propeller circle and F_a the surface of all blades or wings together. Every propeller type has a fixed F_a/F relation.

5.15.4. Sense of Rotation

To determine the sense of rotation of a propeller, always stand behind the boat and look forward. If the propeller rotates counterclockwise, then it is a left-hand propeller, and if rotates clockwise then it is a right-hand propeller. It is the engine which always determines the sense of rotation of the propeller, which can, however, be reversed by using a reversing gear.

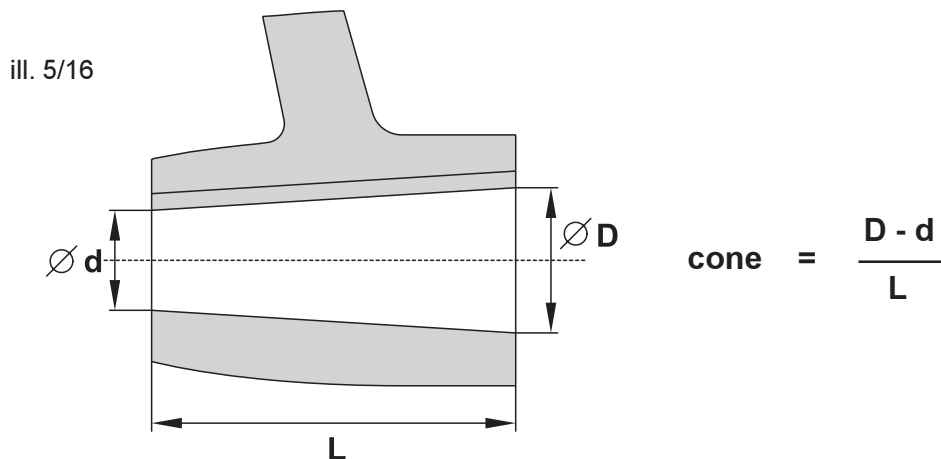
5.15.5. Number of Blades

The number of blades is determined by the speed of the boat, the number of rotations of the propeller, and the type of boat (dumb barge, fisher boat, glider), and is first of all a matter of experience. In general, for standard boats up to a length of approx. 70 ft (20 m), with an engine speed of more than 800 rpm., propellers with more than three blades are being used. If much speed at low revolutions is required, in particular on larger boats, even propellers with more than three blades are used. This should also be determined by specialists. For the same boat and the same engine the diameter of a four-blade propeller may be by 10 % less than that of a three-blade propeller. On sailing boats often a two-blade propeller is used which lessens the resistance and reduces the efficiency for an aliquot part only.

5.15.6. Axle hub

To permit a proper and centric mounting of the propeller on the propeller shaft, the propeller should be provided with a well fitting conical hub and a spline. Mostly the cone's pitch will be 1:10. In the United States and in England one may also find cones with 1:12 and 1:16.

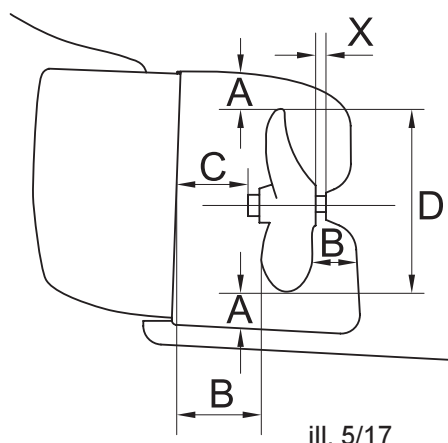
Conicity of a hub is told by the difference between the largest and the smallest diameter, divided through the hub length.



5.15.7. Adjustment of Propeller Pitch

In case of a too high or too low propeller pitch, a specialist may adjust the blades within a certain limit, which, however, should be avoided as far as possible. It is a difficult task and, moreover, it is almost impossible to modify the pitch close to the hub, and to obtain a uniform pitch in every diameter of the propeller chosen at random. On principle, the pitch never should be modified for more than some cm, and this only in case of no other solution.

5.15.8. Space between Propeller and Boat



The maximum propeller diameter results from the shape of the hull. The illustration shows a displacer but even for a glider the conditions are similar. The most important size **A**, the space between propeller and hull, should be at least 2" (50 mm) resp. 10 % of the propeller diameter (noise, malicious vibrations). Size **B** should be approx. 30 % of size **D**. **C** = 3/4" (20 mm) more than the propeller hub length in order to avoid a dismantling of the oar in case of a propeller change.

X = space propeller - stem bearing 1" (25 mm)

5.15.9. Sediments

When removing sediments from the hull, pay special attention to the propeller. Salt water in particular, but also sediments and vegetation cause additional resistance, and thus a smaller efficiency resulting in a lower speed. In general, lower propeller speeds bring about higher efficiency and less vibrations compared to high speeds.

5.15.10. Choice of Propeller

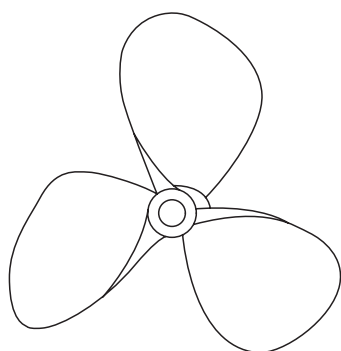
There are a couple of coarse rules:

In general, for a "water displacer" a 3-blade propeller with Fa/F of approx. 0,51 will be sufficient. More or larger blades do not make sense.

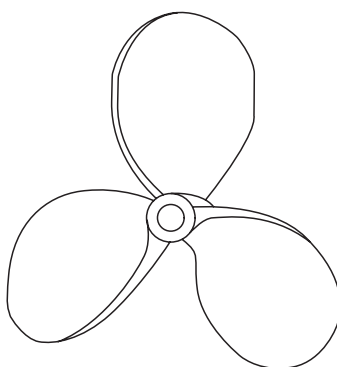
For semi-gliders we generally recommend 3- or 4-blade propellers with Fa/F of 0,54 to 0,74. For gliding boats, 4-blade propellers with Fa/F of 0,54 to 0,74 may be considered.

Most propellers are made of bronze, but propellers made of metal or aluminum are also available.

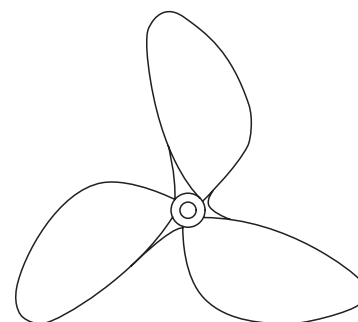
Various propellers with examples of application:



ill. 5/18
3-blade
high-speed propeller



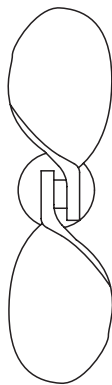
ill. 5/19
3-blade propeller
for commercial use



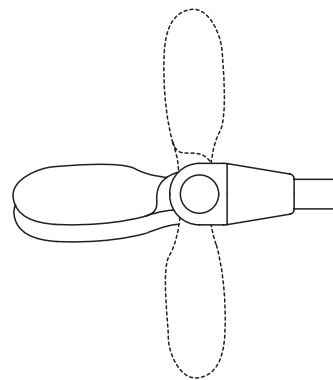
ill. 5/20
3-blade propeller
to be applied in regions
with strong algae and algae
vegetation



ill. 5/21
2-blade propeller to be applied
on sailing boats



ill. 5/22
2-blade folding propeller to be applied
on sailing boats



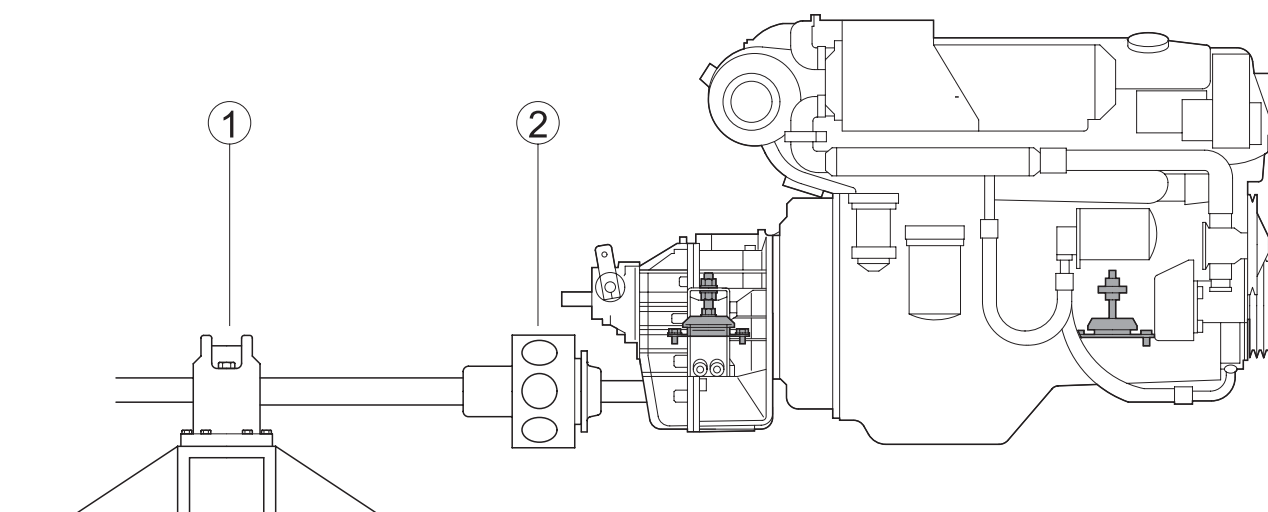
5.15.11. Cavitation

Propellers which have not been computed correctly (e.g. a propeller with a too large pitch) may cause cavitation (formation of steam bubbles). Cavitation may damage the propeller and occurs in case of a too high underpressure on the suction side of the propeller.

5. 16. PROPELLER - THRUST BEARING RESP. STEP BEARING

All reversing gears covered by our product offer are provided with attached axial bearings for the traction and shearing forces of the propeller shafts. In case of normal load conditions, no other thrust bearings are required. For very strong loads, e.g. industrial operation on ice, separate thrust bearings may be required. In such cases, an elastic coupling between reversing gear and thrust bearing is always to be installed in order to avoid axial tensions between the two thrust bearings.

With a shaft length exceeding the standard size, a separate step bearing is to be installed. The step bearing cannot take axial forces.



ill. 5/23

1 thrust bearing
2 elastic coupling

6. COOLING SYSTEM

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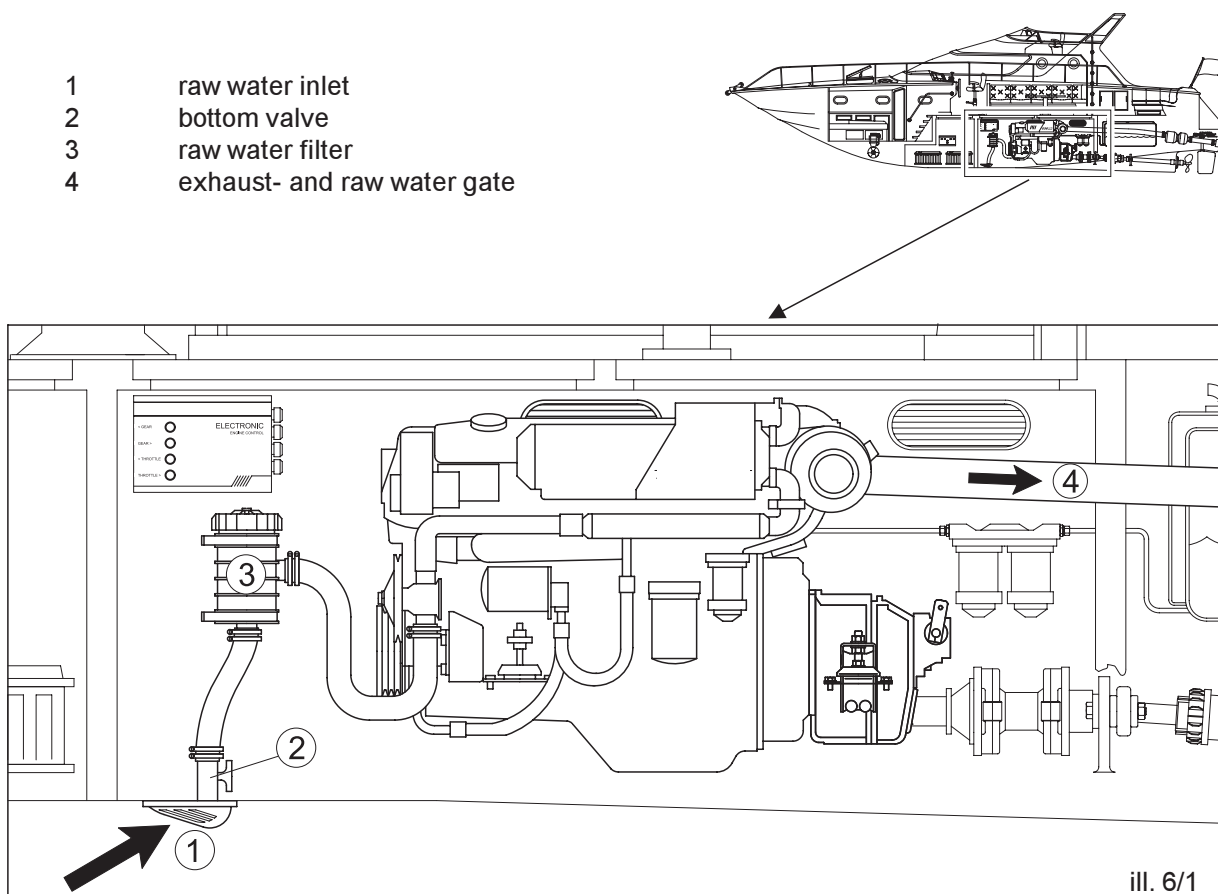
6. COOLING SYSTEM

NOTES

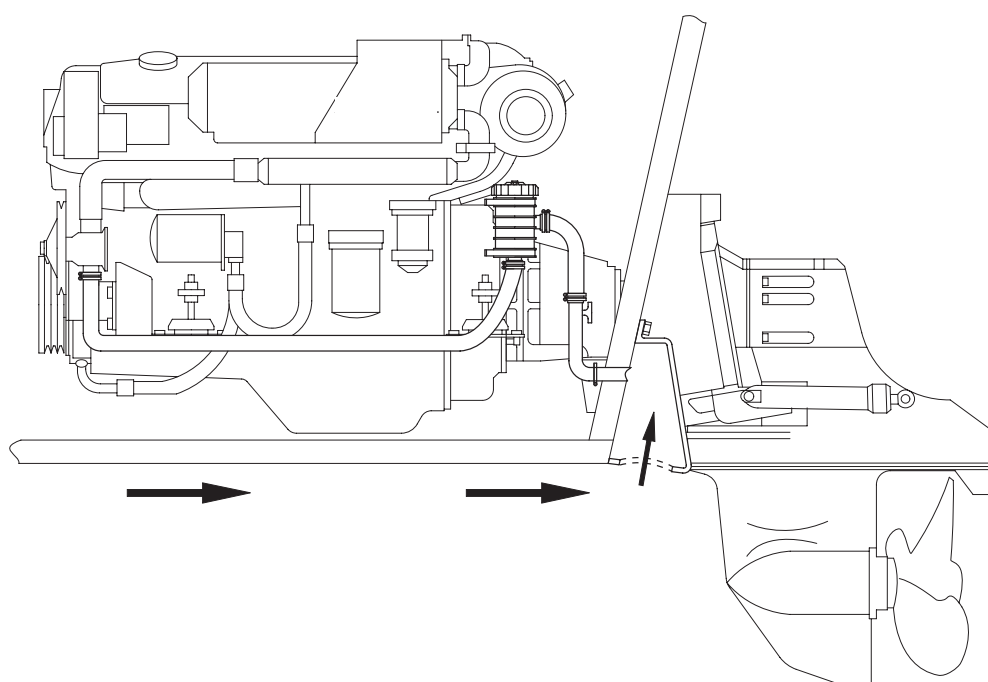
6. COOLING SYSTEM

6.1. SCHEME OF RAW WATER COOLING WITH GEARBOX

- 1 raw water inlet
- 2 bottom valve
- 3 raw water filter
- 4 exhaust- and raw water gate



6.2. SCHEME OF RAW WATER COOLING WITH STERNDRIVE



6. 3. RAW WATER PIPES

Raw Water Pipes Dimensions in mm and inches	4 + 6 Cyl. Engine	
suction pipe, inside diameter	32	1 1/4"
suction pipe, outside diameter	42	1 5/8"
hose, bottom valve - sea water pump, inside diameter	32	1 1/4"
connection for bottom valve, thread		R 1 1/2"
pressure pipe, inside diameter	32	1 1/4"
pressure pipe, outside diameter	42	1 5/8"
hose for pressure pipe, inside diameter	32	1 1/4"
connection for outgoing water and exhaust connection / sprinkler	90	3,5"
min. rate of flow of raw water in l/min and gal./min	> 140	> 30

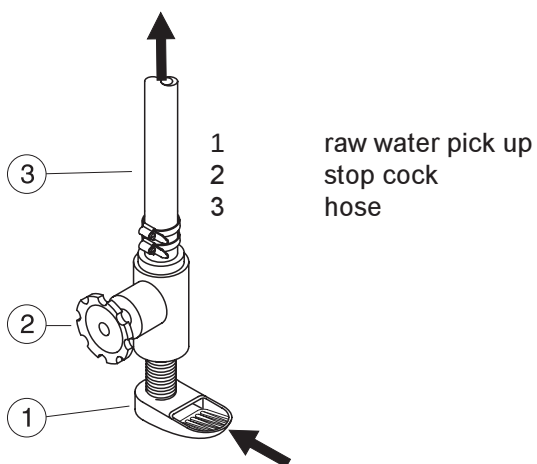
6. 4. RAW WATER PICK UP AND BOTTOM VALVE

The raw water pick up is to be provided within appropriate distance to the raw water pump of the engine, to avoid a suction of air when the boat rolls.

Max. suction height of the raw water pump is approx. 9 ft (3 m) for standard installation. If required, the suction height may be increased by loop-laying of the suction pipe so that the pump can start filled up with water. On top of the loop an air cock is to be provided which is to be closed when the engine is stopped, to avoid a rising effect. Before starting, the cock is to be opened.

On wooden boats the raw water inlet should preferably be made of red metal (brass unsuited: corrosion due to high zinc content). On steel boats red metal is recommended too. If the materials used for the hull and the raw water inlet are very different with regard to their galvanic characteristics, the inlet is to be electrically insulated from the hull. Flow area of raw water inlet and screen should be large enough to avoid a throttling and thus a smaller water supply to the pump.

The pipe should be laid in smooth curves to avoid unnecessary throttling, and preferably be made of copper-nickel tube. To eliminate tensions, lay it in a curve and terminate it with a reinforced rubber hose at the raw water pump. The hose should be designed with steel spiral, otherwise the underpressure in the suction pipe may cause a collapse of the hose, thus no more guaranteeing a sufficient natural water supply.



ill. 6/3

Inside diameter of the floor cock should at least be equal to the suction pipe diameter, see "dimensions raw water pipe". Make sure that the cock does not cause a reduction in flow. On wooden boats, connect the bottom valve to the ship bottom through a board lead-in with through screws. Provide a proper sealing between valve and ship bottom.

NOTE: On motor boat installation the grid of the water pick up must be aligned to the front (driving direction), therewith on increasing boat speed the water will be pressed into the external cooling system.

On sailing boat installation the grid of the ater pick up must be aligned to the rear (aft), therewith water can't be pressed into the external cooling system, when the boat is undersailing conditions with stopped engine.

The bottom valve must be closed if the boat rides at anchor.

Apply a proper sealing agent, e.g. Permatex, on the screw passages. Sheet boats should have a screwed pipe joint welded to the ship bottom, on which the bottom valve is fastened with screws. On the bottom side, a screen is to be fixed. Apply a proper sealing agent between valve and screwing thread.

When fixing the floor valve, there should be sufficient free space around the valve to permit an easy opening and closing of the valve. If this space is too small, an intermediate piece can be fixed below the valve. In many cases a remote control will be required.

6. 5. RAW WATER FILTER

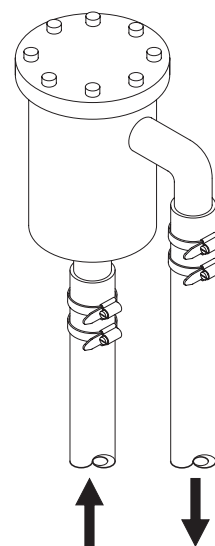
During coasting trade, on the pier etc., it cannot be avoided that small particles of mud, sand and other dirt enter into the water inlet.

A filter in the suction pipe must be fitted so that these contaminations can be separated. A raw water filter also helps to increase the pump life, thus preventing engine defects due to insufficient cooling water supply.

Ill. 6/4 shows one of the Sherewood filters which may be installed with easy access in a bulkhead.

In case of severe contaminations it may be necessary to install a filter of special size.

The minimum flow of the filter is 140 l/min.



ill. 6/4

6. 6. COOLING WATER PIPES / EXHAUST CONNECTION

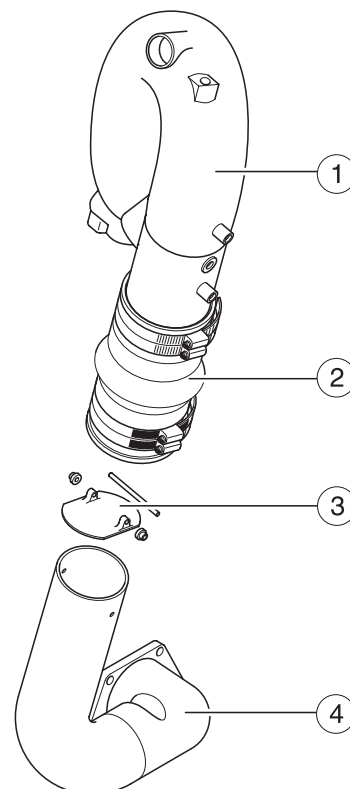
All STEYR MOTORS MARINE Diesels are equipped with a water cooled exhaust gas elbow, as shown on ill. 6/5 . At the exhaust gas muzzle the raw water is injected into the tail pipe for cooling of the exhaust gases.

When designing the exhaust elbow particular importance was attached to a relatively high exhaust duct in order to avoid the entering of back wash. In the adjoining exhaust pipe a splash flap is to be installed in addition.

In case of insufficient difference in level between exhaust gas outlet and sea water surface (boat loaded) a high riser exhaust elbow (optional) is to be installed.

See section 8 Exhaust System.

- 1 exhaust gas elbow
- 2 connecting piece
- 3 splash flap
- 4 tail pipe with flange



ill. 6/5

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7. FUEL SYSTEM

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7. FUEL SYSTEM

NOTES

7. FUEL SYSTEM

7. 1. GENERAL

Assembly of the individual components of the fuel system must ensure an optimum sealing and fire-resistance. Before starting these works, plan the location as well as the type of fuel tanks. Decide for a good quality in order to avoid a leakage of fuel on the cocks. A leak fuel system always means the risk of trouble and fire.

The fuel quantity may be split up to several fuel tanks, thus keeping the center of gravity low and retaining certain trim potentials for the hull.

When installing the fuel tanks adequate room is to be provided with ventilation. Connect filling fixture and tank with an impregnated cable, unless being already connected electrically. Also provide grounding of the tank.

When planning the assembly, always try to store the tanks in a separate area in order to minimize as far as possible the risk of fire in case of an eventual fuel leakage.

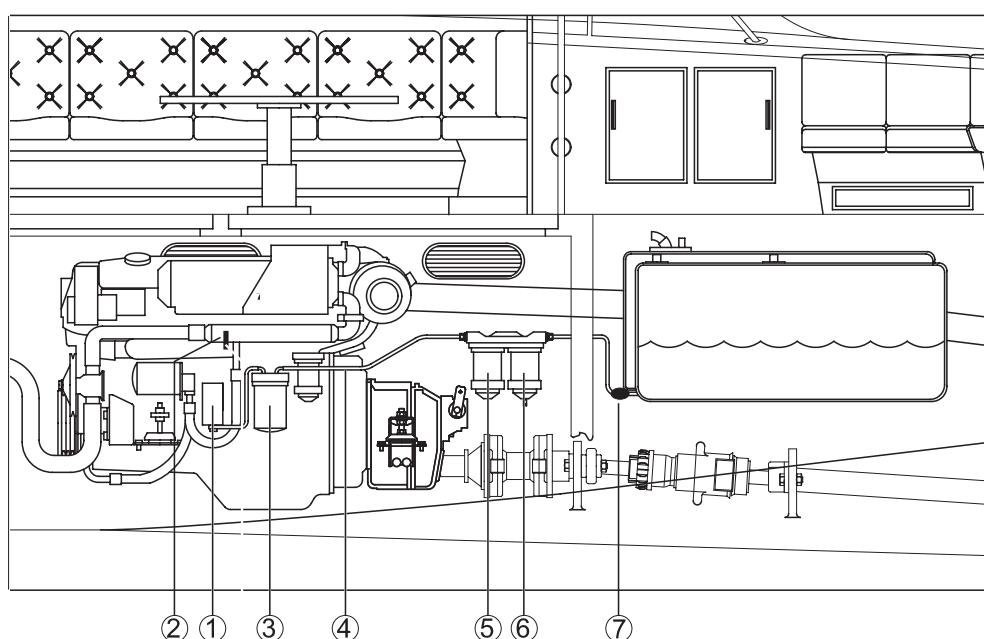
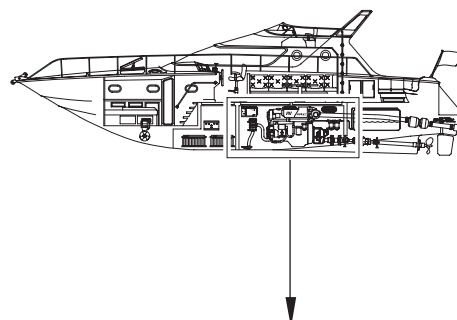
For assembly of the fuel tanks, proceed with greatest care, to avoid leakage or water inlet.

STEYR MOTORS insist that a water separator is fitted into the fuel system before the fuel pump, as drops of water in the fuel are ideal transporters of dirt and rust through narrow pipes. One drop of water may cause a locking of the fuel pump, thus cutting the fuel supply. Particularly with diesel engines, small deposits of dirt or rust may result in heavy damages on the injection pump and nozzles.

The water separator should be installed as close as possible to the tank, but with enough space for water drain and exchange of filter inserts.

For selection and dimensioning additional filters and water separator must have an flow of min. **300 l/h** or **65 gl/h**, as the rate of flow of the electric fuel pump must not be reduced.

- 1 fuel pump
- 2 fuel return
- 3 fuel filter
- 4 feed line
- 5 coarse filter
- 6 water separator
- 7 anti-syphon valve

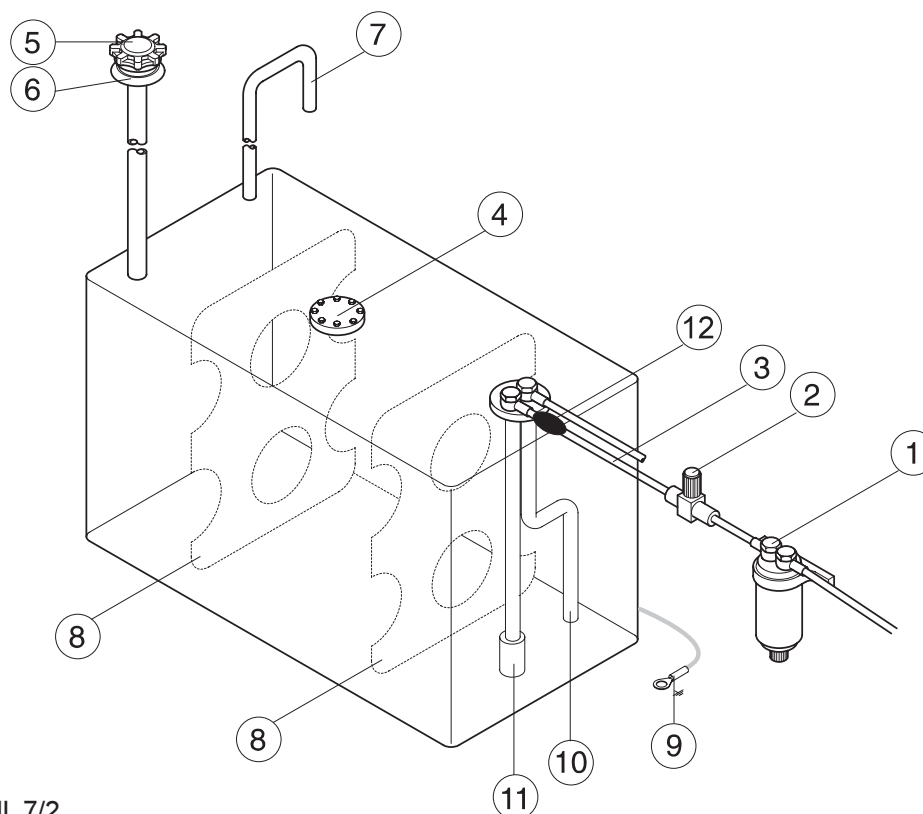


ill. 7/1

7. 2. FUEL TANKS

If possible, arrange the fuel tanks at engine level or higher. In case of a lower arrangement, max. suction height of the feed pump is to be considered which is 1 m for all kinds of engines. Please consider that the suction head is calculated from the lower end of the suction pipe, i.e. approx. 1" (2,5 cm) over the tank bottom. The return pipe should lead into the tank at the level of the screen but with some distance to it, to avoid a foam formation of fuel.

In case of arrangement of the tanks at a level lower than the admissible suction height of the feed pump, the fuel is to be pumped up to a daily tank by a manually operated pump or motor pump. In this case, the fuel flowing back from the engine is pumped into the daily tank.



ill. 7/2

- 1 water separator, rate of flow > 65 Brit. gl/h (> 300 l/h)
- 2 fuel stop cock
- 3 fuel pipe, outside diameter 3/8" (10 mm) for a length of 20 ft (6 m). For longer lines, use a 1/2" (12 mm) pipe.
- 4 inspection cover
- 5 filler socket - cover
- 6 lead-in sleeve made of fuel-resistant rubber, with drain possibility
- 7 air-vent pipe, diameter at least 1 1/2" (38 mm)
- 8 guide bulkhead
- 9 ground connection
- 10 return pipe
- 11 suction pipe, complete with screen (distance to tank bottom 1" / 25 mm)
- 12 anti-siphon valve

NOTE: If demanded by **THE US COAST GUARD** install a anti-siphon valve which must be opened by fuel pump suction to withdraw fuel from the tank and which will remain closed without fuel pump suction, preventing siphon action created by a break at any point in the fuel feed system.

The valve shall be designed and sized to provide the required fuel flow of 65 Brit.gl/h (300 l/h) to the engine.

7. 3. MATERIALS

If possible, the fuel tanks should be made of stainless steel (Nirosta) . Light metal, steel plate or plastic may be used too.

Copper plate, galvanized or pot-galvanized plate are no suitable materials for fuel tanks.

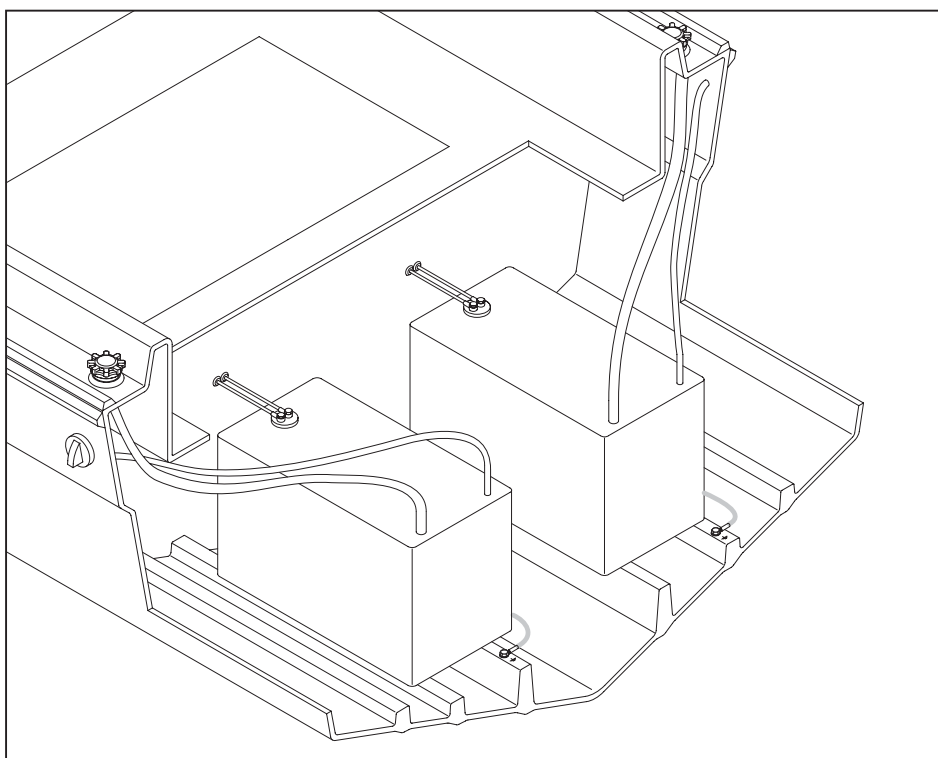
7. 4. TWIN FUEL TANKS

For a lateral arrangement of the tanks in the boat, a construction acc. to ill. 7/3 may be chosen.

Connect the tanks on top and on bottom with pipe lines equipped with stop cocks. Min. inside diameter of the lower connecting pipe should be 3/4" (19 mm) in order to permit a filling of the tanks, if they are installed alongside, from both sides of the boat.

The fuel pipe from the engine has to depart from the lower connecting pipe of the tank (only valid for tanks with bottom drain). An additional fuel filter or water separator is to be installed in front of the feed pump on the injection pump.

In case of a daily tank, it is recommended to connect the fuel return pipe to this tank which reduces the filling intervals.



ill. 7/3

7. 5. FUEL PIPES

Min. inside diameter of the fuel filler socket should be 1 1/2" (38 mm). Length of the socket should be chosen in such a way that the distance to the tank bottom is approx. 2" (50 mm). Connect the filler socket from the tank to the deck union by means of a pipe joint to the tank socket. On the deck lead-in a sleeve made of fuel-resistant rubber is to be provided. If possible, rubber hoses should be avoided. When using a rubber hose, it should be of fuel-resistant, reinforced quality. Always connect tank and deck union by a grounding cable, unless there is a metallic contact.

The air-vent pipe is to be laid from the highest point of each tank to a protected area on deck. On the upper end of these pipes a curve of 180° is to be provided which avoids the entering of water into the tanks. The air-vent pipes should also be arranged in such a way that e.g. flowing out gas cannot be ignited or enter into the rooms aboard.

The fuel pipes for the engine can be made of seamless, tempered copper tubes or of steel tubes type Bundy tube. Steel tubes are much stronger than copper tubes, and should, therefore, be used as far as possible.

The hose pipes have to comply with specific conditions of use and respective local waterway regulations (see hints in the preface).

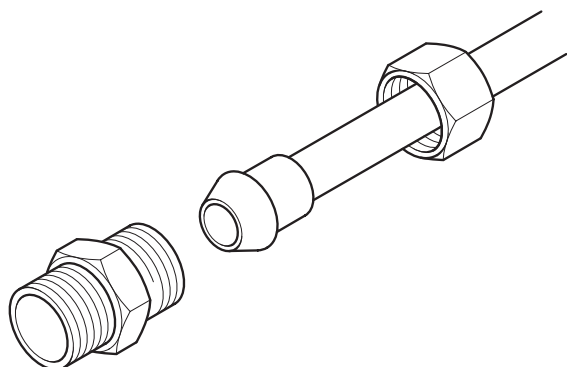
Specific data for fuel hoses:

- synthetic rubber hose with plies of fabric
- size DN 8
- resistant to Diesel fuel
- fire proof
- temperature range: -30 bis +30 °C
- operating pressure 145 psi (10 bar)

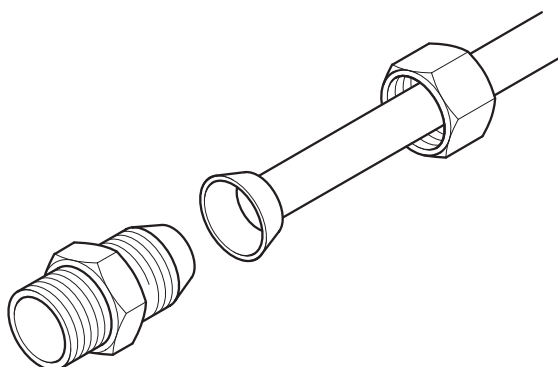
Up to lengths of 2 ft (6 m), outside diameter of the fuel suction pipe should be 3/8" (10mm). A longer suction pipe will require a larger diameter, e.g. 1/2" (12mm)

From the overflow valve on the engine a fuel return pipe to the tank, or to the daily tank if available, is to be laid. Min. outside diameter of the fuel return pipe should be 3/8" (10mm).

On the engine side, fuel pipes are always to be installed.



ill.7/4
fuel pipe with brazed tapered piece



ill.7/5
flanged fuel pipe

The connections of the fuel pipes are to be flanged with a special tool. Loose or soft soldered tapered pieces must not be used. When using tapered pieces, these are to be fixed on the pipes by brazing. The best solution is, however, a flanging of pipes.

Well tighten the fuel pipes on planks or rigid supports, to avoid vibrations or pipe fracture.

8. EXHAUST SYSTEM

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8. 7. MEASUREMENT OF COUNTERPRESSURE	6

8. EXHAUST SYSTEM

NOTES

8. EXHAUST SYSTEM

8. 1. GENERAL

Install the exhaust line with as few as possible bends and as high as possible curve radius. Provide sufficient pipe diameter to keep the backpressure within admissible values. (see 8.7)

The exhaust system may be designed in 3 different ways:

- 1 **Dry exhaust pipe, insulated**
- 2 **Wet exhaust pipe (water flow in the pipe)**
- 3 **Exhaust pipe with water jacket (double-walled, water-cooled)**

The dry exhaust pipe releases large amounts of heat into the engine compartment thus requiring good insulation. The wet exhaust pipe and the exhaust pipe with a water jacket are cooled and therefore mostly do not need insulation. The water flow in the exhaust pipe also has a noise-absorbing effect.

8. 2. MATERIALS

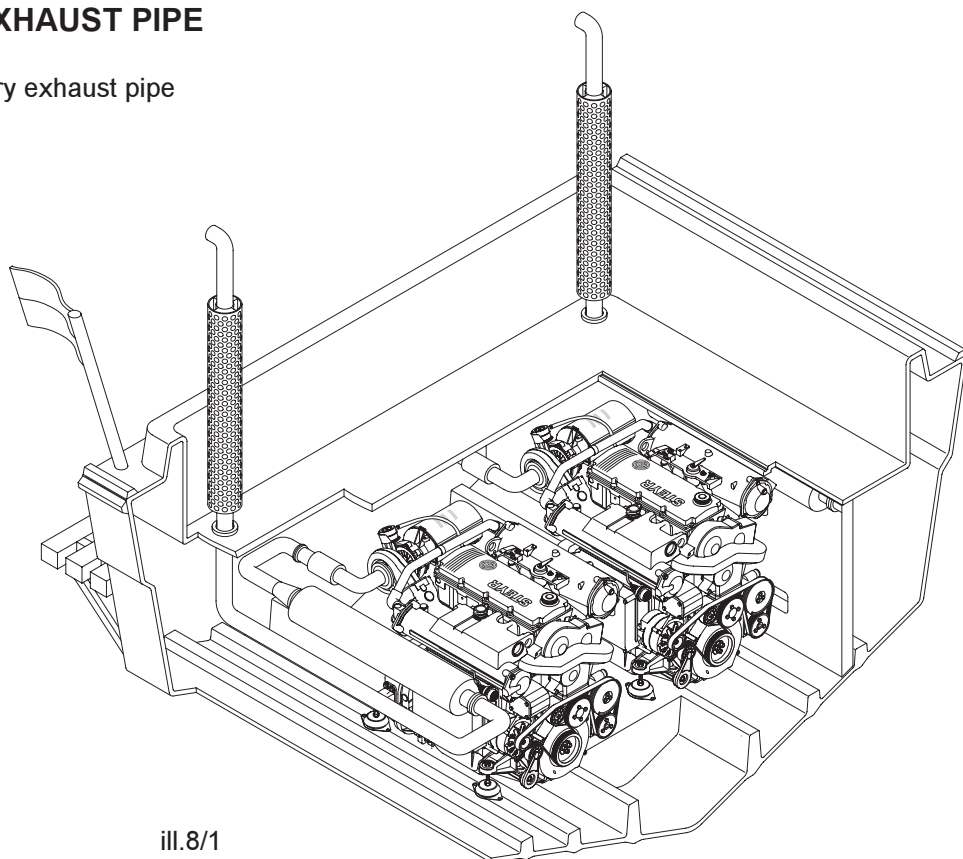
Exhaust gases from a Diesel engine also contain sulfur compounds which mixed with water may corrode the metals. For this reason, copper tubes are unsuited for exhaust pipes.

Exhaust pipes with cooling jackets are to be made of acidproof steel tubes, to guarantee satisfactory service life. In case of water inlets into the exhaust pipe, the line may be made completely or partially of special exhaust rubber hose.

Dry exhaust pipes are preferably made of acidproof steel tubes. Pipes made of stainless or galvanized steel tube also guarantee a relatively satisfactory service life.

8. 3. DRY EXHAUST PIPE

Scheme of a dry exhaust pipe
for 2 engines

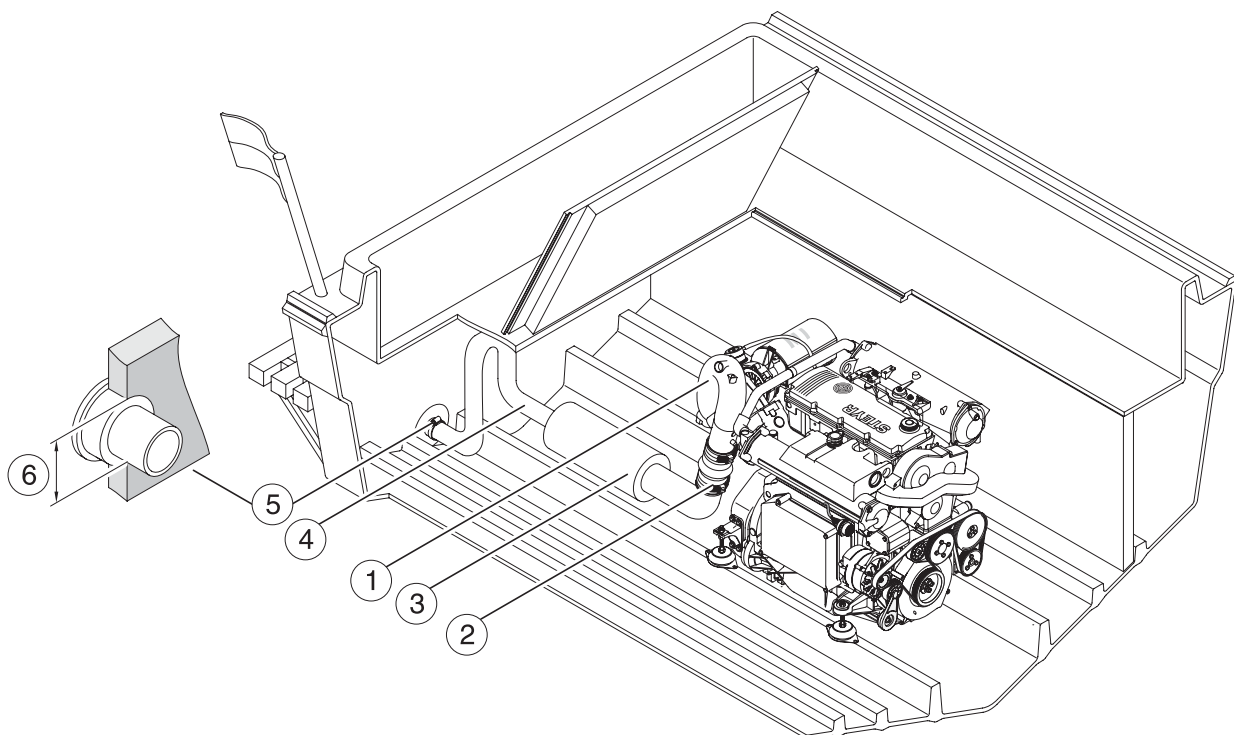


ill.8/1

8. 4. WET EXHAUST PIPE

Wet exhaust pipes for turbo engines are designed according to Ill. 8/2.

All rubber hoses are to be connected at each end by 2 corrosion-resistant hose clamps.



ill. 8/2
wet exhaust pipe with muffler
TWIN-MI 236 TD (example)

1	wet exhaust elbow	5	board lead-in with rubber expansion piece sealing the bore in the boat transom
2	exhaust rubber hose	6	bore diameter in boat transom
3	water-cooled muffler		
4	exhaust pipe, bend over water line		5" +/- 0,5 line (127 +/- 1 mm)

With all kinds of exhaust pipes assembly is always to be done avoiding the entering of water from the exhaust pipe into the engine, otherwise severe damage to the engine due to hydro lock and corrosion of cylinders may occur.

ATTENTION: When laying the exhaust pipe through bulkheads and similar make sure that the pipe does not touch material which transmit vibrations onto the hull, thus causing resonance noise. In case of lead-in pipes, take special care that the exhaust pipe will not cause a combustible heating of the surrounding material.

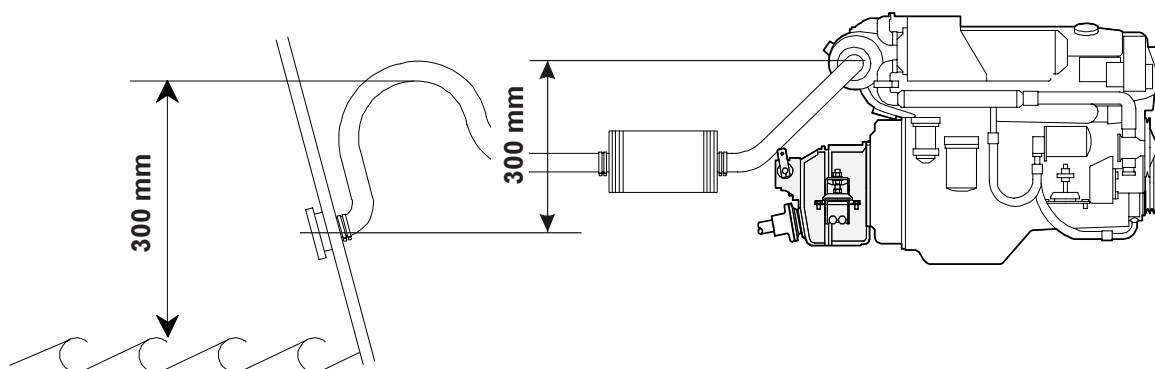
ATTENTION: For the assembly of exhaust pipes to turbo charged engines; The turbo charger must never have to support the weight of the exhaust system.

8.4.1 Exhaust for Inboard Engines

The exhaust outlet in the hull should be 12" (300 mm) below the exhaust elbow.

For correct installation the highest part of the exhaust system must be at least **12" (300 mm)** above the water line with a loaded boat, see ill. 8/3.

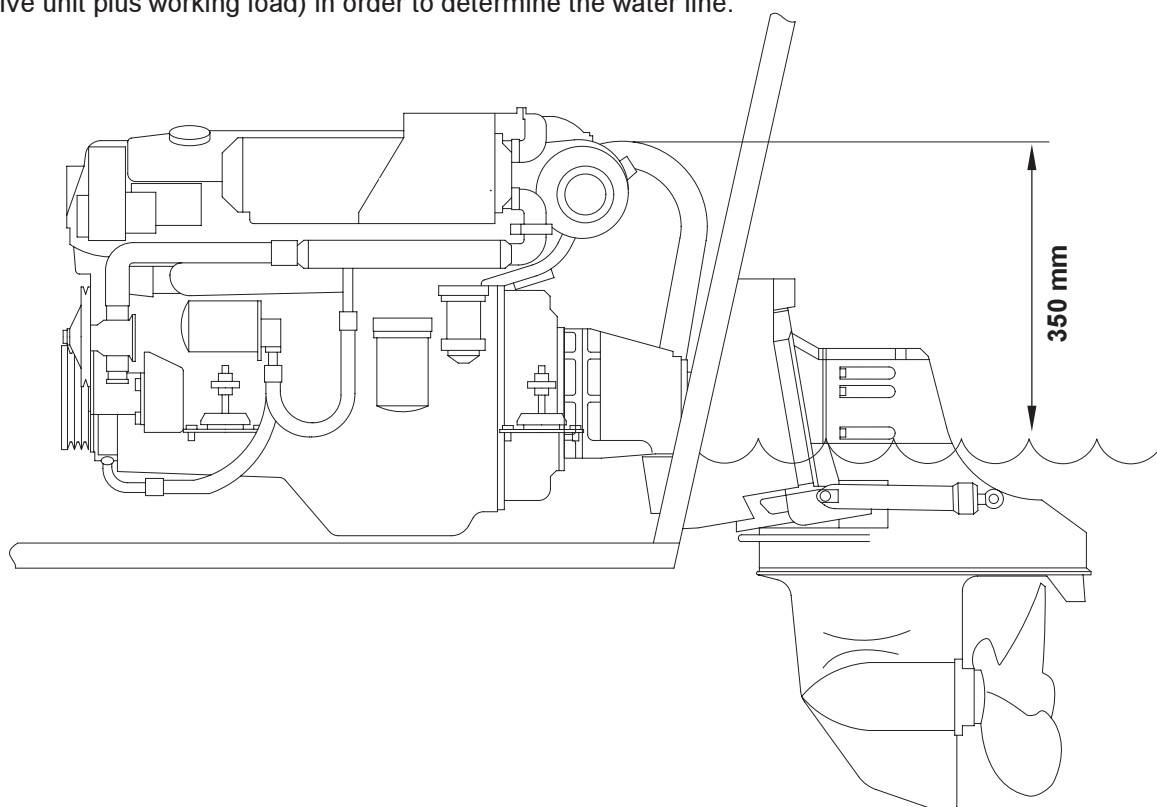
Install the drain cocks at the lowest points of the exhaust pipe.



ill. 8/3

8.4.2 Exhaust for Stern Drive Engines

Precondition for a correct installation is compliance with the min. height of **14" (350mm)** from the exhaust system highest point to the water line A (ill. 8/4). If required, launch the boat with its real load resp. load distribution (weight of drive unit plus working load) in order to determine the water line.



ill. 8/4

8. 5. DIMENSIONS OF EXHAUST PIPE

engine	6 Cyl. Engine		4 Cyl. Engine	
dry exhaust pipe (acidproof steel tube)	mm	inch	mm	mm
inside diameter	84	3,3"	84	3,3"
outside diameter	90	3,5"	90	3,5"
wet exhaust pipe (industrial rubber hose)				
inside diameter	127	5"	110	4,3"
outside diameter	140	5,5"	127	5"

8. 6. CONDENSED-WATER COLLECTOR

Exhaust gases of an internal-combustion engine contain water vapor which may condense and be converted into water which in the worst case flows back into the engine.

With an exhaust pipe inclined in direction of the engine, therefore always install a condensed-water collector behind the water-cooled standbend. Provide the condensed-water collector with a cock or a drain plug at its bottom.

Min. diameter of the condensed-water collector should be 1" (25 mm) and its length 12" (300 mm)

8. 7. MEASURING OF BACKPRESSURE

After assembly of the exhaust system, always check the backpressure; most simply by a pressure gauge connected by means of an adaptor instead of the temperature sensor for exhaust raw water. Measuring is then to be done with nominal capacity of the engine.

The **max. admissible exhaust backpressure** for STEYR Marine Engines is 100 mm WS = **100 mbar** (WS = water column)

Exhaust backpressure:

< **100 mbar** = no loss in efficiency, > **200 mbar** = loss in efficiency, > **300 mbar** = not acceptable

9. AIR INTAKE AND VENTILATION

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9. AIR INTAKE AND VENTILATION

NOTES

9. AIR INTAKE AND VENTILATION

9. 1. GENERAL

Power of the engine is influenced by a number of different factors. The most important ones are air pressure, air temperature and exhaust gas counterpressure.

In case of large deviations from the standard values the diesel engine also loses power. This loss can even be to such an extent that a planing boat cannot plane.

To guarantee a proper function of the engine and its full power it is vital that the supply- and exhaust air ducts are designed large enough and functionally.

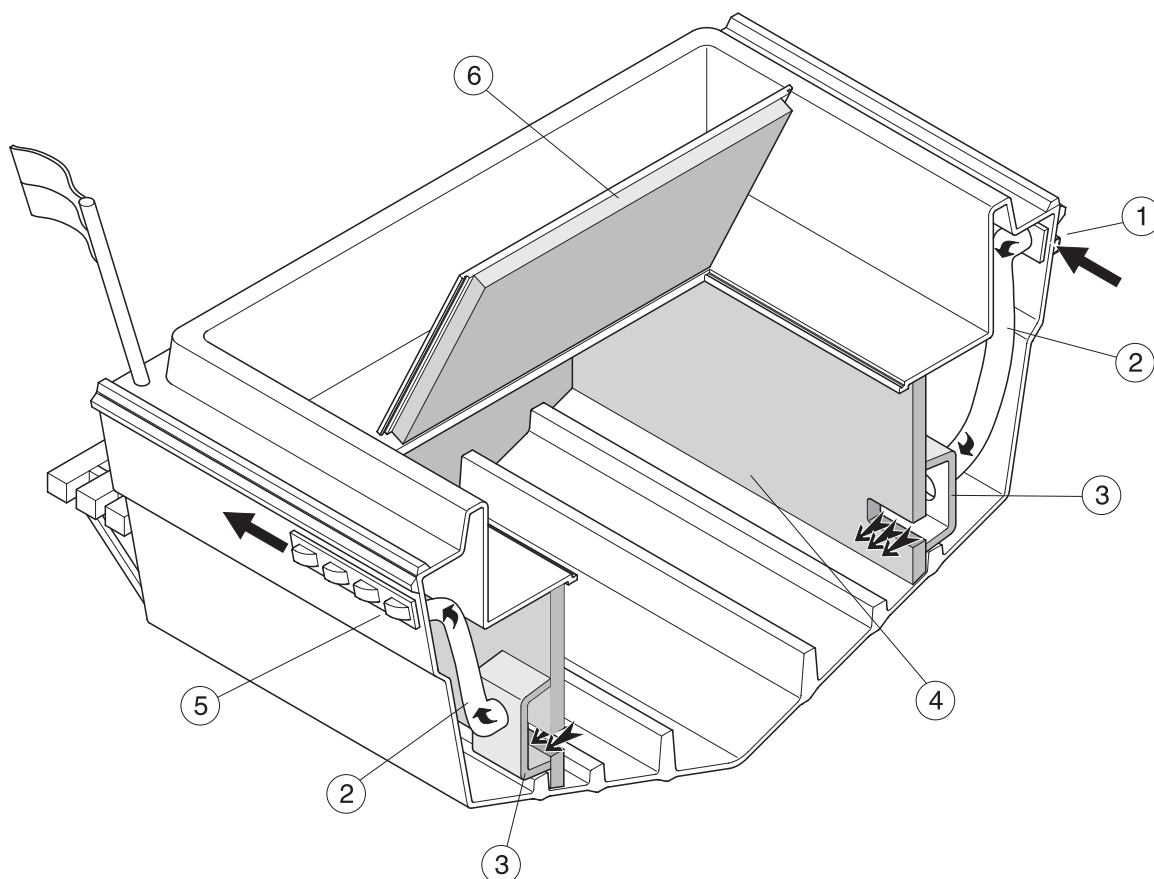
Two main demands are to be fulfilled:

- 1.) Sufficient supply of air (oxygen) to the engines, in order to ensure a fuel combustion without residues.
- 2.) Ventilation of the engine compartment to keep the temperature level in the compartment low.

An adequate ventilation also improves the operating conditions for the whole electrical equipment of the engine.

ATTENTION: If people are in the engine compartment, the ventilation is to be adapted.
Local safety rules and legal regulations are to be followed.

III.9/1 Example for air inlet and ventilation of engine on sport boats, and similar applications.



- | | | | |
|---|---|---|--|
| 1 | air inlet, water separator
(effective surface: see chart) | 4 | sound-absorbing engine compartment
(see section "insulation") |
| 2 | air pipes (dimensions: see chart) | 5 | outlet for exhaust air, with inactive engines.
For running engines air will be sucked in at
1 and 5. Cross section as for 1. |
| 3 | sound absorber (see section "insulation")
In the sound absorber no restriction may
occur. Inner distance between walls
= pipe diameter | 6 | sound-absorbing hatches |

9. 2. ENGINE POWER AND AIR TEMPERATURE

Indicated engine power is based on an air temperature of +25°C, an atmospheric pressure of 997 mbar, a relative atmospheric moisture of 30%, a fuel temperature of +20°C and a sea water temperature of +25°C (acc. to test standards).

Pay particular attention to good air supply and ventilation, to achieve engine power and life as high as possible. If the intake air of the engine cannot be kept below +40°C, the power of turbo engines with boost intercooling will drop for up to one percent per 10°C rising engine temperature.

9.3. CALCULATION OF AIR INLETS AND DUCTS

Planning of an engine system should consider the following basic facts.

All internal-combustion engines, irrespective of trade mark or type, **require a certain min. quantity of oxygen (air) for their combustion process.** However, Diesel engines operate with a little more excess air than carburetor engines.

All engines also radiate a specific **amount of radiation heat** to the ambient, e.g. to the engine compartment. Therefore, air inlet and air ducts are to be dimensioned spaciouly in order to achieve a very low velocity of airflow.

9. 4. PIPES FOR SUPPLY AIR AND EXHAUST AIR

It is of great advantage to consider the supply- and exhaust air ducts already during construction and to provide them in the hull or superstructure, thus avoiding exposed pipes.

To supply the engine with sufficient combustion air is relatively easy but it is much more difficult to carry off the radiation heat.

The engine itself sucks in the air very effectively and takes it from everywhere. If dimensions of the supply- and exhaust air ducts are too small, the engine will suck in the air from the exhaust air ducts. Due to missing ventilation high temperatures will arise in the engine compartment.

Most of the engine's radiation heat is to be conducted from the engine compartment.

This is an imperative requirement for keeping the engine temperature under the max. limiting value.

9. 5. TEMPERATURE IN ENGINE COMPARTMENT

Since the indicated engine power is based on a test temperature of +25°C, it is important to keep the temperature of the intake air as low as possible. Increased temperature will always cause a power loss.

Max. temperature for areas where electric components are installed is 70°C (for starter and generator special regulations are to be applied however)

9. 6. INLET CROSS SECTION - AIR CONSUMPTION OF ENGINE

Min. requirement for proper ventilation and air supply for "pleasure" boats are 4 pipes with a diameter of 3" (75 mm) each; two pipes for engine supply air, one pipe for ventilation of engine compartment, and one pipe, equipped with a fan (efficiency 440 ft³/min / 11 m³/min.), for exhaust air of engine compartment.

The engine needs a certain quantity of air for the combustion process, which requires a certain min. flow area for the air stream.

This area may be calculated with the following formula:

$$A = 1,9 \times \text{engine power in KW (Diesel engines)} = \text{cross section of area in cm}^2$$

For example:

256 marine $A = 1,9 \times 184 \text{ kW} = 54,2 \text{ inch}^2 (349,6 \text{ cm}^2) = 8 \frac{1}{4}" (210 \text{ mm diameter})$

164 marine $A = 1,9 \times 120 \text{ kW} = 35,4 \text{ inch}^2 (228,0 \text{ cm}^2) = 6 \frac{3}{4}" (170 \text{ mm diameter})$

Max. possible combustion air consumption per engine unit at 20°C / 990 mbar

256 marine $1190 \text{ yd}^3/\text{h} (910 \text{ m}^3/\text{h})$

174 marine $798 \text{ yd}^3/\text{h} (610 \text{ m}^3/\text{h})$

The value is based on free influx and a pipe length up to 3 feet (one meter) with a max. bend of 90°. When using longer pipes or several pipe bends, correct the cross section by multiplication with a coefficient. See chart.

number of pipe bends	length of pipe in meters/yard				
	1	2	3	4	5
1	1	1,04	1,09	1,13	1,20
2	1,39	1,41	1,43	1,45	1,49
3	-	1,70	1,72	1,74	1,78

9. 7. INLET CROSS SECTIONS - VENTILATION OF ENGINE COMPARTMENT

To keep the temperature in the engine compartment at the admissible value, a part of the radiation heat is to be conducted resp. expelled from the engine compartment.

The supply- and exhaust air pipe should be of the same size, to achieve a low velocity of flow and thus a low sound level.

Pipe cross section for supply- and exhaust air is computed with the following formula:

$$A = 1,65 \times \text{engine power in kW} = \text{cross section of area in cm}^2$$

For example:

256 marine $A = 1,65 \times 184 = 47,1 \text{ inch}^2 (303,6 \text{ cm}^2) = 8" (200 \text{ mm}) \text{ diameter}$

164 marine $A = 1,65 \times 120 = 32,0 \text{ inch}^2 (198,0 \text{ cm}^2) = 6 \frac{1}{4}" (160 \text{ mm}) \text{ diameter}$

9. 8. FANS

To permit an effective ventilation of the engine compartment, which keeps the temperatures low, a **suction fan** is to be installed in the exhaust air duct.

Attention: Never install the fan in the supply air duct. This would cause an excess pressure in the engine compartment, with the risk of gas- and air leakage in the other compartments of the boat.

9. 9. CHOICE OF BLAST

The blast is to be provided for the following air volume flow:

air volume flow (m³/min) = 0,07 x engine power in kW

For example:

256 marine 0,07 x 184 = approx. 17 yd³/min (13 m³/min)

164 marine 0,07 x 120 = approx. 11,8 yd³/min (9 m³/min)

Total pressure rise by the blast should be 3/8" wc (10 mm WS) (100 Pa).

Based on these two values, air volume flow and total pressure rise, the blast may be chosen.

9. 10. FUNCTION OF AIR INLETS

Satisfactory function of air inlets and air outlets must also be guaranteed with bad weather conditions. They should have water guards, and normally sound insulation too.

Distances between air inlets and air outlets should be as long as possible.

Provide for a good air flow.

Attention: If the distance between inlet and outlet is too short, the air may circulate which results in a bad ventilation effect.

9. 11. POSITION OF AIR PIPES

Lay the pipes for air supply of the engine up to the air filter's side, but with a lateral distance of 8" - 12" (20 - 30 cm), to absolutely avoid any entering of water into the engine.

Air inlets and air outlets must never be installed in the stern transom. In this area the air is mixed with water and exhaust gases and, therefore, never may be conducted into the boat.

For Diesel engines, the air supply pipes should end at low level in the engine compartment, but not too low to cause a fluidity stop (brackish water) which chokes the air supply.

Exhaust air pipes are to be provided diagonally on the opposite side of the engine.

10. AUXILIARY PROPULSION - PTO

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10. AUXILIARY PROPULSION

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10. AUXILIARY PROPULSION - PTO

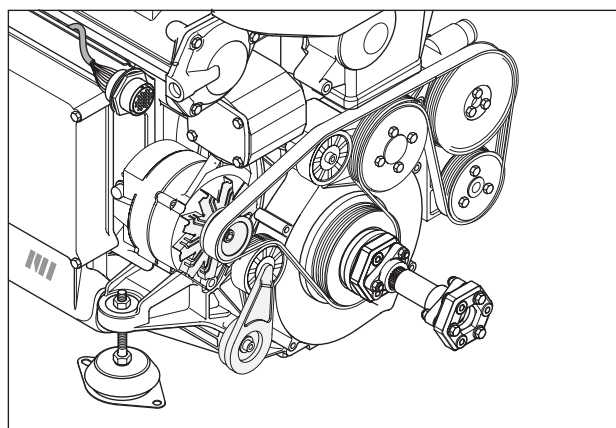
10.1. GENERAL

STEYR Marine engines optionally may be equipped with an auxiliary propulsion at the front end of the crankshaft. See ill. 10/1 and 10/2.

Max. decline of output of the auxiliary propulsion is limited however. See chart.

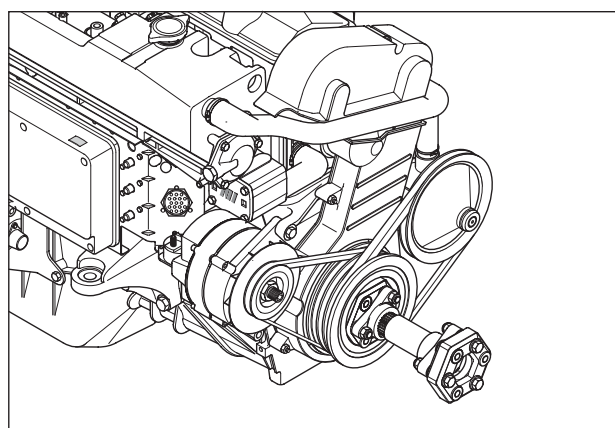
engine	outside diameter of belt pulley on crankshaft	propulsion, max. output
4 Cyl. Engine	5,3" (135 mm)	100Nm (28,3kW) at 2700 rpm.
6 Cyl. Engine	6,5" (165 mm)	100Nm (28,3kW) at 2700 rpm.

4 Cyl. Engine



ill.10/1

6 Cyl. Engine



ill.10/2

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11. SAFETY COVERS

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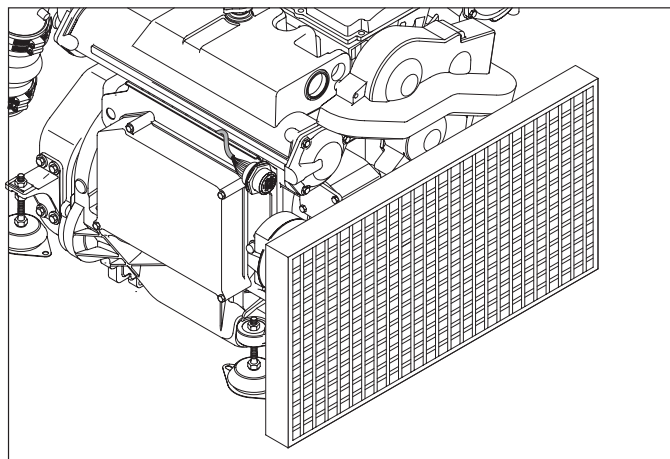
11. SAFETY COVERS

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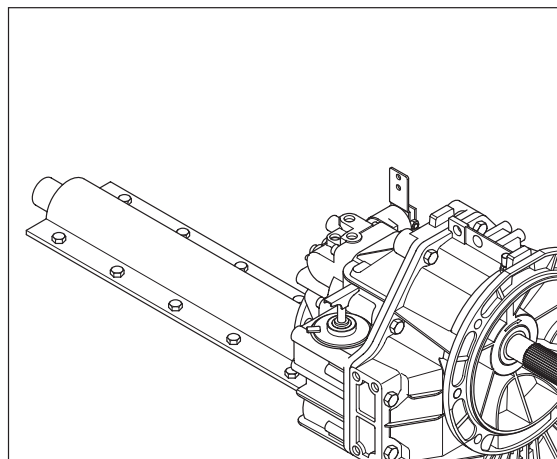
11. SAFETY COVERS

11.1. GENERAL

All rotating shafts and belt drives being exposed are to be provided with safety covers. Their construction and size must prevent accidents, e.g. if somebody slips and, in falling, comes close to a source of danger. To permit an inspection of the engine control, its protection is to be constructed as net or grate. Fix the protection by means of screws and nuts, to allow an easy removal for maintenance.



ill.11/1 example for a belt drive cover



ill.11/2 example for a stem shaft cover

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12. BILGE PUMPS

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12. BILGE PUMPS

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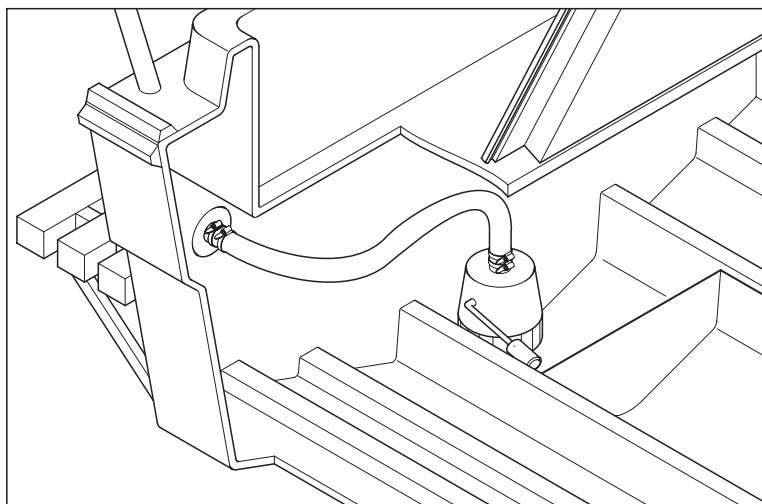
12. BILGE PUMPES

12.1. GENERAL

To achieve max. Lenz power, pumps and piping are to be chosen as follows.

length of boat (m)	hand bilge pumps volume flow (m ³ /h)	power-driven bilge pumps (m ³ /h)	nominal width of bilge pipes main bilge/branch bilge pipe (mm)	
< 8	3	5	32	
< 10	5	6	32	
< 15	5	7,5	40	
< 20	6	9	50	40
< 24	6	10,5	60	40

permanent pipe, copper tube 3/8", outside diameter



ill.12/1

From the suction side of the pump a copper tube or reinforced rubber hose is to be laid towards the keel. Provide the suction pipe at its lower end with a **relief valve** and a **screen**, the latter to permit easy cleaning. The relief valve prevents a reflux of water of the permanent pipe in case of a damage on the pump wheel.

The bilge pump always should have constant water supply, to avoid dry operation. Connect the permanent pipe at the delivery side of the pump. Board lead-in at the delivery side of the bilge pump should be at higher level as the permanent pipe connection.

Equip the permanent pipe with a stop cock. This cock must be closed with inactive engine. Otherwise, sea water may be pressed into the boat through the permanent pipe, passing the bilge pump, unless the suction pipe is provided with an effective relief valve. At the lowest points of the pipes drain cocks are to be installed, so that water can be drained in case of danger of frost.

To avoid pumping out of dirty water in the port or close to the beach, install a cock on the suction pipe of the bilge pump. If drainage is not required, this cock should let pass the air onto the pump, thus preventing that water is sucked in from the keel.

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13. CABIN HEATING

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13. CABIN HEATING

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13. CABIN HEATING

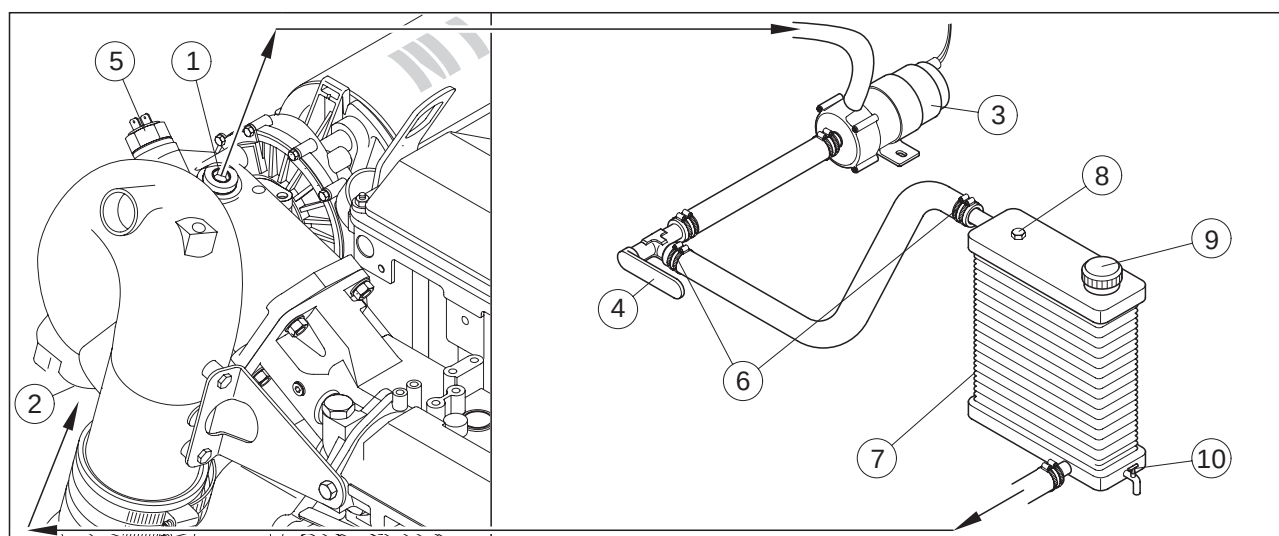
13. 1. SEPARATE HEATING

Heating for the ship's cabin or for passenger rooms may be connected to a separate generating set run by petroleum, Diesel, liquid gas etc.

Separate heating is always to be preferred, for large heating installations anyway, to prevent the engine from running at too low operating temperature. Such an installation also guarantees a uniform heat input, whether the engine runs or not. Several products are available on the market. For assembly, current safety rules are to be considered.

However, heat can also be taken from the engine's cooling system, and be supplied to a small radiator. But this heat is only available when the engines runs.

13.2. CABIN HEATING, CONNECTED TO ENGINE



ill.13/1

- | | | | |
|---|------------------------------|----|---------------------------------|
| 1 | hot water outlet from engine | 6 | hose with twin hose clips |
| 2 | water return to engine | 7 | cabin heating (event. with fan) |
| 3 | heating pump (STEYR option) | 8 | venting screw |
| 4 | angle with stopcock | 9 | filler socket |
| 5 | thermal-lag switch | 10 | drain cock (at lowest point) |
- opening temperature 70-74 °C.

In a Diesel engine 35 to 40 % of the energy supplied by the fuel are used as motive power. The rest fades as exhaust heat, frictional losses, radiation and through the cooling system.

The heat passing off the cooling system may be used to some extent to heat the cabin. In such case, it is extremely important that not too much heat is taken, which causes the engine to run at too low operating temperature. A quick rise of the engine temperature to operating temperature is also important. If the engine operates too cold (below 65°C approx.) wear will increase considerably.

This means that too large heatings and too soon starting heatings, i.e. heatings starting before the operating temperature of the engine is reached, may cause severe damages on the engine.

It is recommended to install in the feed line to the radiator a thermostat with the same or about 2° lower opening temperature as the engine thermostat. A circulating pump may also be required.

This maintains the operating temperature of the engine at normal speed and keeps it at the correct level. At the same time, the radiator gets maximum heat.

Never run the engine at idle motion just to keep the heat in the cabin.

To ease water circulation through the heating water pipes should be large enough. If one of the radiators is situated higher than the engine, separate compensating tanks are to be installed. The compensating tank should be higher than the radiator, but max. height over the engine must not exceed 2 m.

Attention: When installing a separate compensating tank for the engine's cooling system, this tank should be the the highest part of the cooling system.

The heating's inlet and outlet connections on the engine must be provided with stop-cocks in order to permit a disconnection of the heating, if required.

Provide the heating installation with drain cocks at the lowest points and with relief cocks at the highest points.

For connecting the water pipes to the engines, bores are provided (ex works equipped with paddings). The arrows on the illustrations show the direction of the water stream.

14. NOISE ATTENUATION

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14. NOISE ATTENUATION

NOTES

14. NOISE ATTENUATION

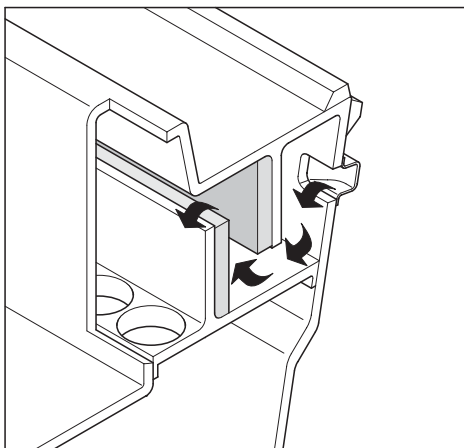
14. 1. GENERAL

In most cases a low noise level is required, which implies an insulation of the machine unit. The disturbing engine noise is transmitted through the hull - i.e. engine base and body - and by the air.

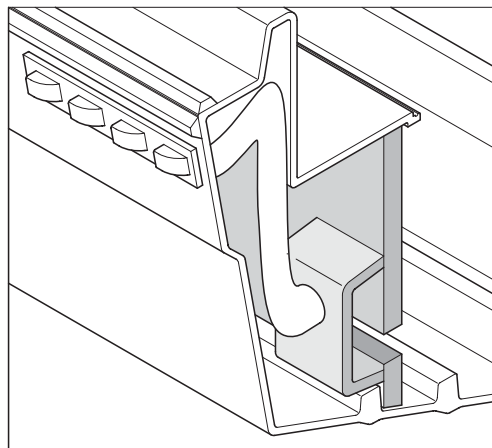
To avoid a propagation of the engine noise through the hull, as first step engine and reversing gear are to be provided with elastic suspensions and elastic propeller shaft coupling (see chapter 3) which results in a reduction of the hull-latent noise.

In addition, the acoustic source is to be shielded as far as possible, to reduce the air-latent noise. This measure above all is a very simple way to reduce the high-frequency noise. However, a small opening in the shielding may already cause a considerable noise leakage. Therefore, insulating material should also be provided below the engine bed, down to the hull, and all inlets are to be sealed with rubber bellows.

14. 2. NOISE REDUCTION



ill. 14/1

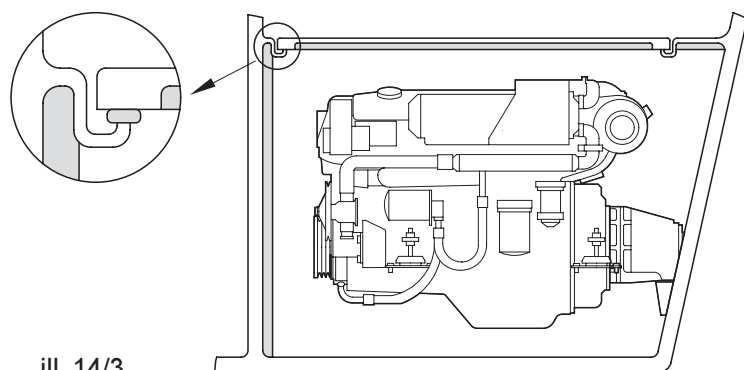


ill. 14/2

Equip the unit with a noise insulation to keep the sound level as low as possible. Provide noise catchers in the engine compartment. Various type are available.

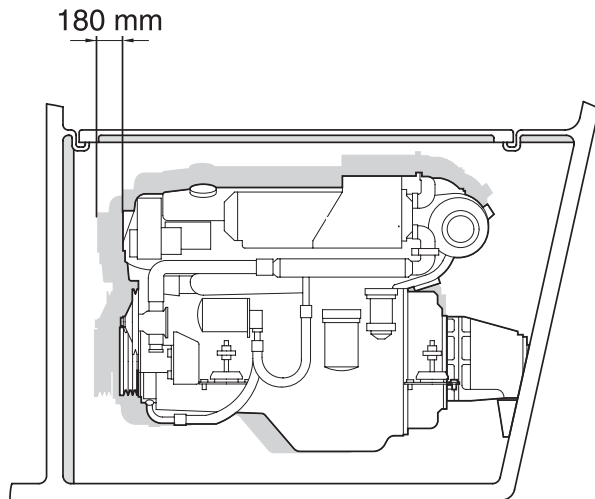
Ill. 14/1 shows a construction with a water drain.

If a water drain is not possible, the air tubes may be bent like a swanneck (ill. 14/2), to avoid the entering of water. Design of the engine compartment should consider enough space for maintenance of the engine. In addition, thickness of the noise-absorbing material is to be considered.

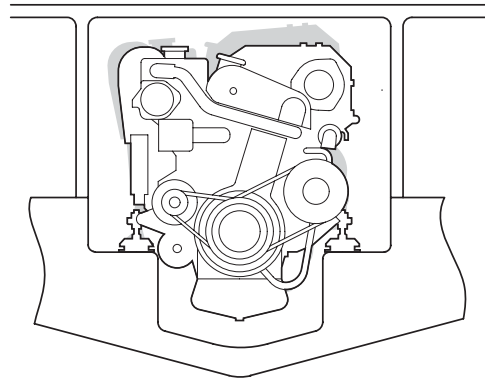


ill. 14/3

Carefully shield the acoustic source. Shielding should go down to the hull. Gaps on hatches and bench covers to be sealed with insulating material (see ill. 14/3) If the engine is under the bottom plate, cover all bulkheads and sheets.



ill. 14/4



Before attaching the noise-absorbing material, make sure that there is sufficient space for movements of the engine during operation. Noise-absorbing material is available in different types and thickness. Provide a free space of 8" (180 mm) (ill. 14/4) in front of the engine, to permit its dismantling.

14. 3. NOISE ABSORBING HOODS AS SUPERSTRUCTURE

On small commodity boats and normally on all sport boats, at first engine and reversing gear are provided with an elastic suspension - see chapter 3. However, in case of an elastic stem tube, no elastic coupling may be mounted.

Then the engine compartment preferably is built as self-contained construction, with a hinged cover as top (ill. 14/3).

Attention: Always consider enough space for maintenance of the engine - see respective operating instructions.

The engine protection is made of 1/12" (2 mm) steel plate or 3/4" (19 mm) plywood.
A 3/8" (10 mm) rubber strip is used as cover sealing.

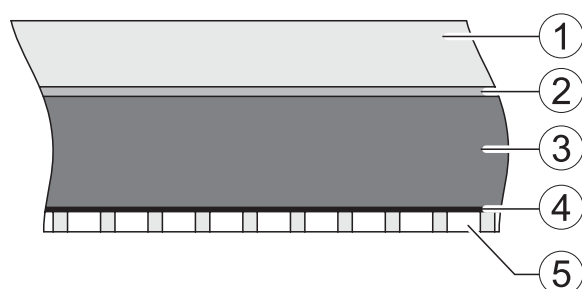
For ventilation of the engine, two air intakes (see chapter 7) for sufficient air supply are to be provided. The air intakes are connected to the bottom edge of the engine compartment by means of rubber hoses which ensures sufficient noise reduction without any further measures.

Exhaust air of the engine compartment is conducted via two noise catchers with the same cross section as that of the air intakes. These noise catchers must be insulated on both sides with the same material used for the inner side of the engine protection.

In hot regions it may be necessary to install fans (see chapter 7.8) for air exhaust.

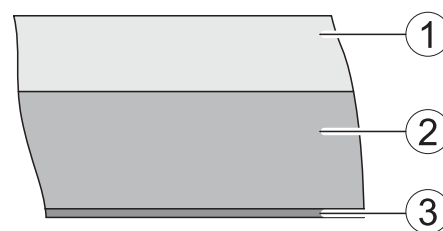
Atmospheric temperature of the engine may rise to a max. value of 40 - 45°C only. However, a temperature as low as possible should be the aim.

14. 4. NOISE-ABSORBING MATERIAL



ill. 14/5
noise-absorbing material for engine hood made of wood (plywood 5/8" / 15 mm) or 1/12" (2 mm) steel plate

- | | |
|---|--|
| 1 | engine hood |
| 2 | lead sheet, 0,5 line (1 mm) |
| 3 | mineral cotton, 2" (50 mm) |
| 4 | plastics foil |
| 5 | perforated aluminum sheet, 0,5 line (1mm), perforation 20% |



ill. 14/6
noise-absorbing material for engine hood made of 1/12" (2 mm) steel plate or wood (plywood 5/8" / 15 mm)

- | | |
|---|--|
| 1 | engine hood |
| 2 | flame-proof absorbing mat, e.g.: "Porolon", "Revertex Acoustics" or Baryfoil. |
| 3 | flame-proof reflecting sound-absorbing foil (ferruginous PVC, thickness 1/10" / 2,5 mm) 15% of the engine-sided surface to be provided with absorbing mat. |

Noise-absorbing material on ill. 14/5 shows a construction for extremely high insulation requirements, also containing a lead sheet layer. This construction is very stable and is also recommended for engine compartments the walls of which are for different reasons weaker than recommended.

Under the same conditions as shown on ill. 14/5, one single layer of a flame-proof insulating mat, e.g. "Porolon", "Revertex Acoustics" or "Barifoil" may be glued directly onto the inner side of the engine protection. This noise-absorbing material will in many cases be sufficient. Use contact glue.

Such material requires little space and is easy to handle. All surfaces to be glued must be completely grease- and moisture-free, to achieve and maintain good adherence.

Many different noise-absorbing materials are available on the market, but only materials meeting the current requirements as to fire protection and noise reduction may be used.

Finished noise-absorbing mats with absorbing layers for soundproofing are also available on the market.

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15. CONTROL STATION

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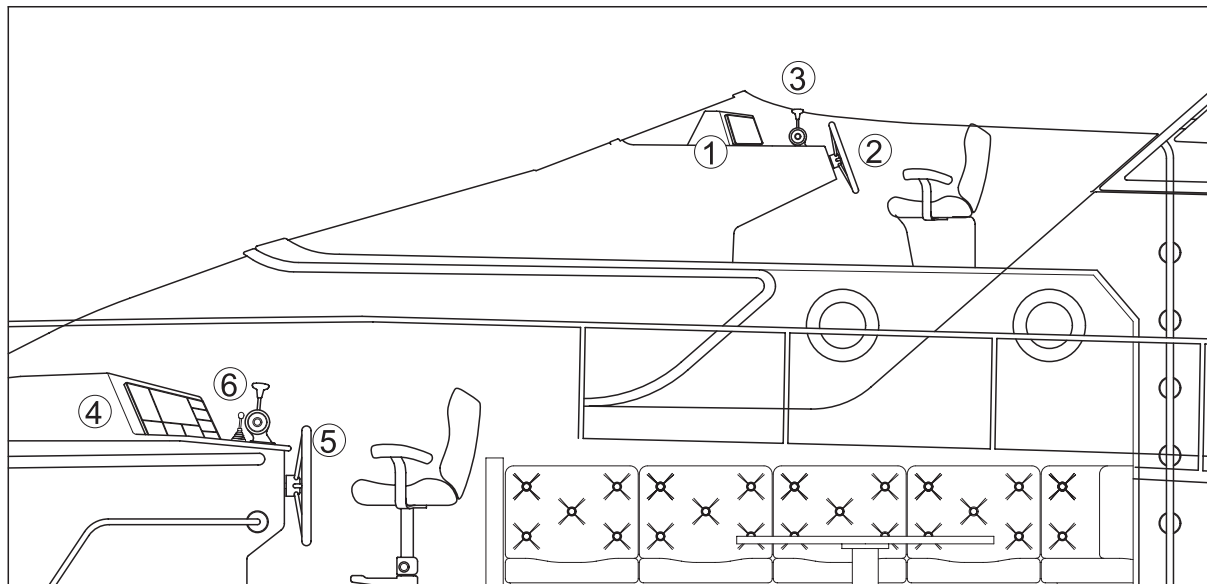
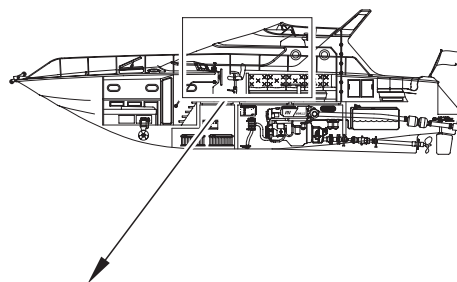
15. CONTROL STATION

NOTES

15. CONTROL STATION

15.1. CONTROL STATION, GENERAL

The design of the control station should enable a functional placement of operating elements, boat control, instruments, navigation equipment and alarm system. That applies for both single and twin control stations.



ill. 15/1

- | | | | |
|---|-------------------------------------|---|---------------------------------------|
| 1 | instruments - top control station | 4 | instruments - lower control station |
| 2 | steering - top control station | 5 | steering - lower control station |
| 3 | control lever - top control station | 6 | control lever - lower control station |

15.2. CONTROL SYSTEMS

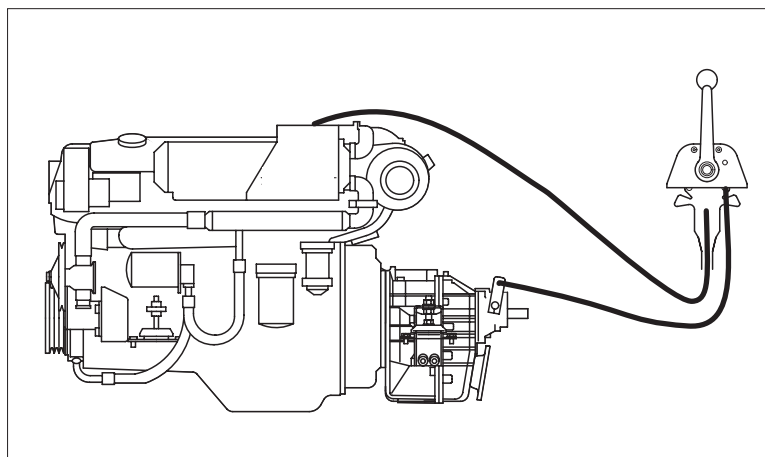
For **STEYR MOTORS Marine Engines** a mechanically operated control is provided. However, other control systems may be used too.

15.2.1. Mechanical Control

With mechanical control, movement of the lever is transmitted through a steel cable in a plastic sleeve onto the engine and reversing gear. This cable is called pressure- and tension cable.

Illustration shows the most current mechanical control with a combined lever for accelerator potentiometer (acceleration) and reversing gear (forward or backward).

For special applications (industrial use), control of accelerator potentiometer and reversing gear may also be done by one separate lever each.



ill. 15/2

15.2.2. Hydraulic Control

Hydraulic control is designed for ships where the distance between engine and control station is too large and pressure- and tension cables often cause undesired play.

In this case control is done by means of hydraulic cylinders triggered by individual control valves. These control valves receive the control commands via the hydraulic liquid of the control levers. A separate hydraulic tank is to be installed.

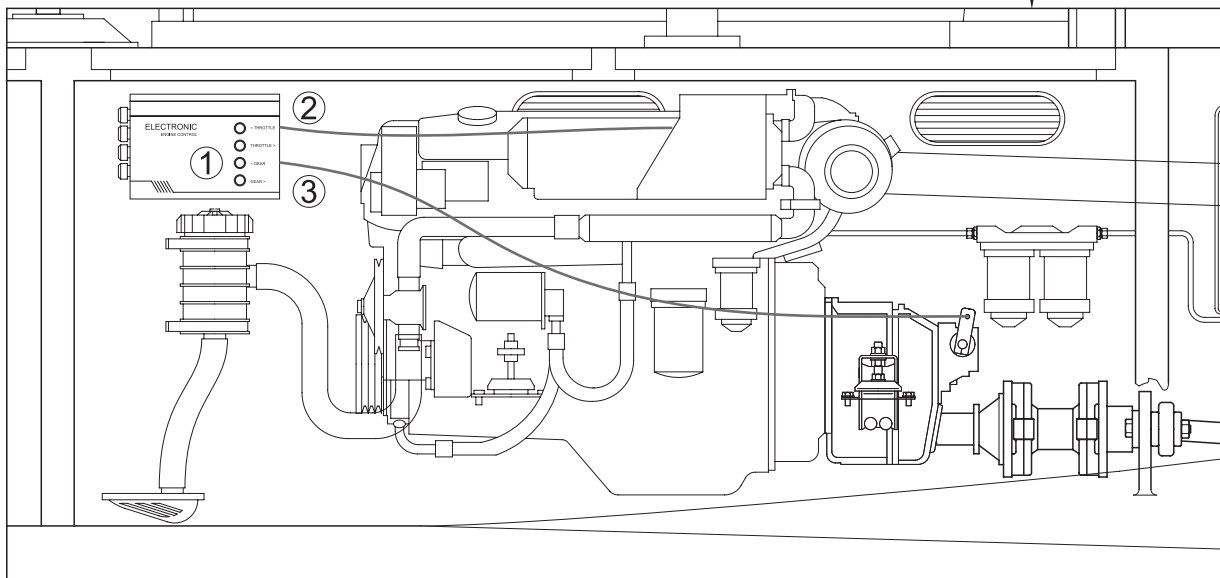
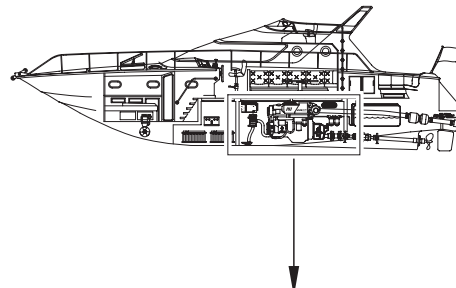
Quality of the hydraulic liquid requires special attention since liquids with a low modulus of extension and a very low viscosity may be used only.

In no case may the hydraulic liquid be merged with different qualities.

15.2.3. Electronic Control

With electronic control, movement of the control lever are converted into electric signals.

In this case, the microprocessor unit plays a central role. It is attached as close as possible to the engine and controls via short tension- and pressure cables the engine and the reversing gear.

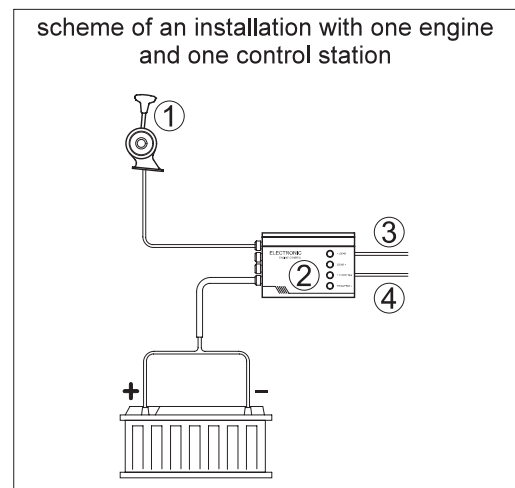


ill. 15/3

- 1 microprocessor unit
- 2 tension- and pressure cable accelerator
- 3 tension- and pressure cable reversing gear

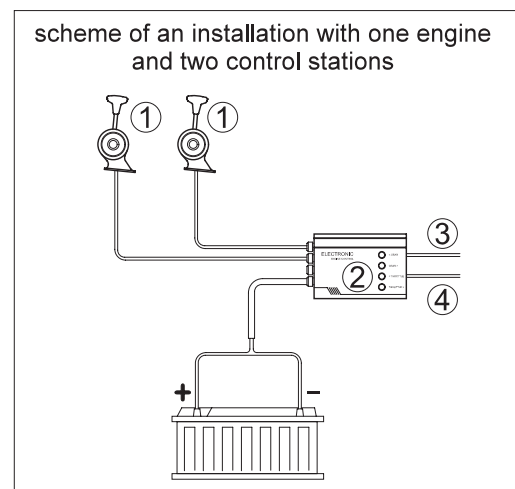
A so-called potentiometer on the control handle imparts the respective position of the handle to the microprocessor unit. In the processor unit this signal is converted via servo-motors into mechanical movements. Depending on manufacturer and design of this processor unit several control levers may be connected.

For the control of twin engines two processor units are required. Compared to mechanical control mechanical differential devices are not necessary.



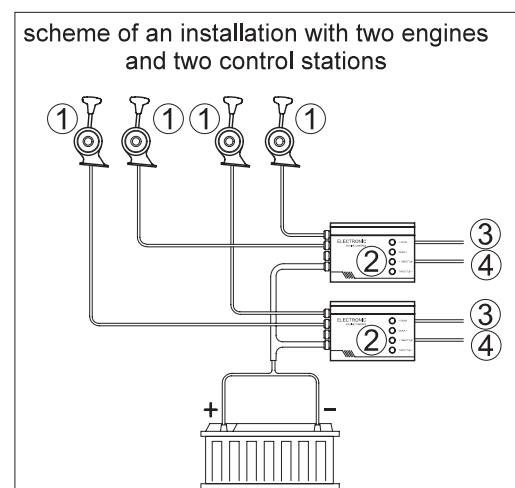
- 1 one single-lever control
- 2 microprocessor unit
- 3 tension- and pressure cable accelerator
- 4 tension- and pressure cable reversing gear

ill. 15/4



- 1 two single-lever controls
- 2 microprocessor unit
- 3 tension- and pressure cable accelerator
- 4 tension- and pressure cable reversing gear

ill. 15/5



- 1 four single-lever controls
- 2 two microprocessor units
- 3 tension- and pressure cable accelerator
- 4 tension- and pressure cable reversing gear

ill. 15/6

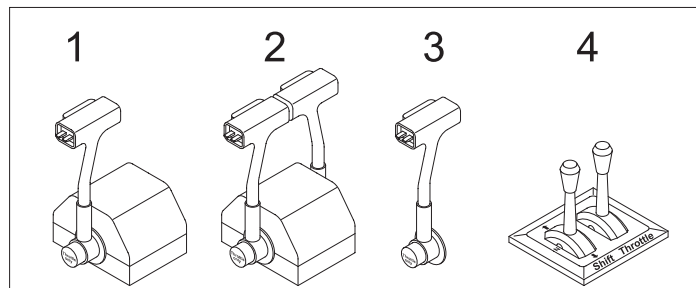
15.3. CONTROL LEVERS

Speed and control levers should be of good quality to ensure a reliable control of the boat. For hydraulic reversing gears we recommend the combined lever control for single- and twin engines. This control is designed in such a way that control of engine speed and hydraulically actuated reversing gear can be done by one single lever. If the engine is equipped with a clutch for mechanical operation, the engine speed is to be controlled by means of a separate gearshift.



ATTENTION: WHEN ENGAGING REVERSING GEARS OR CLUTCHES, THE ENGINE SPEED NEVER SHOULD EXCEED 800 RPM.

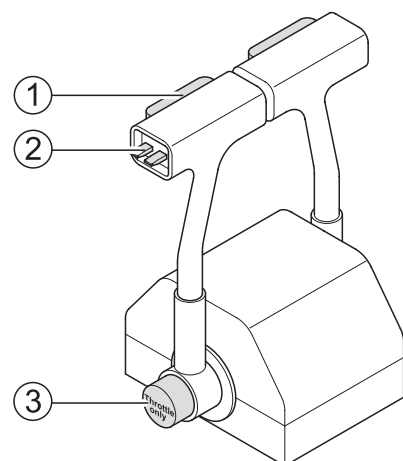
15.3.1. Kinds of Control Levers



- 1 single-lever control, for top assembly
- 2 single-lever control for twin-engine plant, for top assembly
- 3 single-lever control for lateral assembly
- 4 twin-lever control for top assembly

ill. 15/7

15.3.2. Possible Functions of a Control Lever



- 1 safety key: only by pressing key 1, control lever may be moved forward or backward.
- 2 trimming switch
- 3 by pressing key 3, engine speed may be changed without putting in a gear

ill. 15/8

15.4. CONTROL CABLE

Cables provided for the control devices described are designed for function in two operating directions (push-pull function) and available in many different lengths. Cables should not be shortened or extended respectively connected piece by piece.

Cables for reversing gear and engine normally have different lengths. These lengths are to be considered and/or measured exactly when planning the cable run. The cables must be laid unrestrictedly and only be clipped at the spots provided. If necessary, cables may be laid in cable-protection pipes.

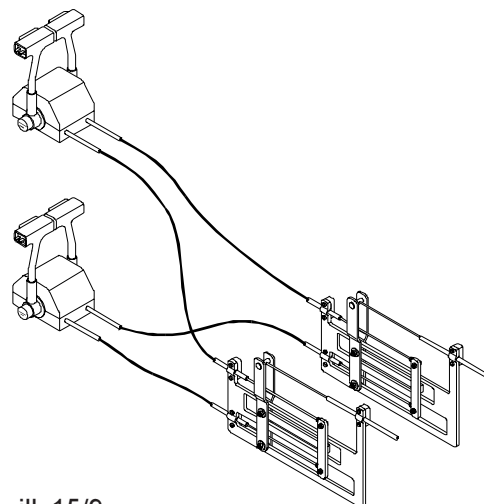
The speed cable must not be clipped closer than 0,9 m to the control, since this cable moves a slightly back and forth during operation.

The speed and reversing gear cables are to be laid in as few as possible smooth curves, to avoid unnecessary friction and clearance losses. Min. curve radius is 150mm.

15. 5. TWIN CONTROL STATIONS

For boats with a top control station (fly bridge), the control of engine and gear may be done via an electrically controlled servo unit or a mechanical shift unit. Manoeuvring and control apparatus are installed twice. Conversion of the control levers between the individual control stations may be done automatically if an omnibus implement is provided. The speed cables of the two controls are connected to the actuator solenoid unit.

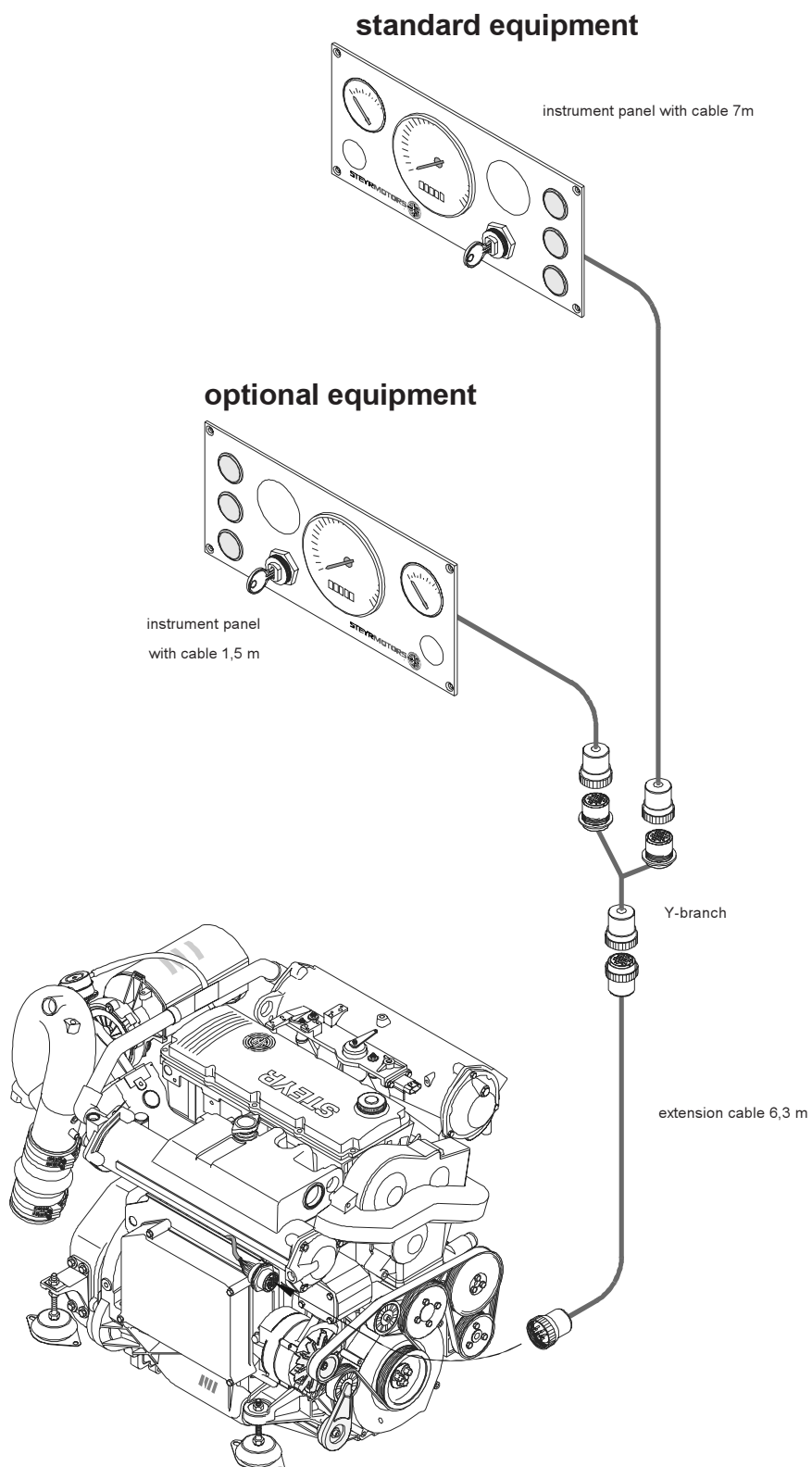
Automatic commutation of the connecting cables between the control stations, one for every engine, should be placed as close as possible to the reversing gear.



ill. 15/9

15. 6. TWIN INSTRUMENT PANELS

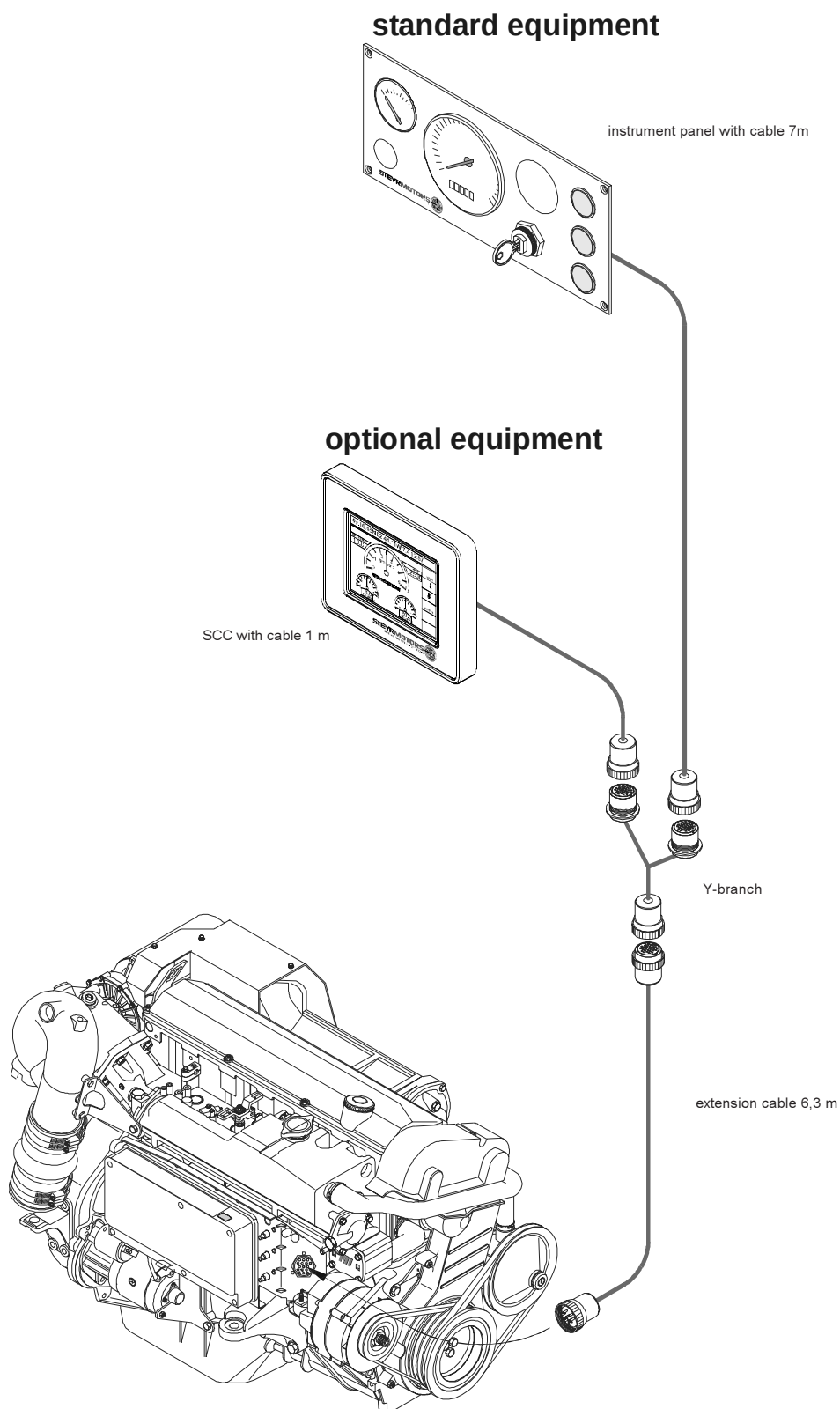
15.6.1 Scheme for second instrument panel



ill. 15/10

NOTE: Oil pressure sender for twin installation must be changed.

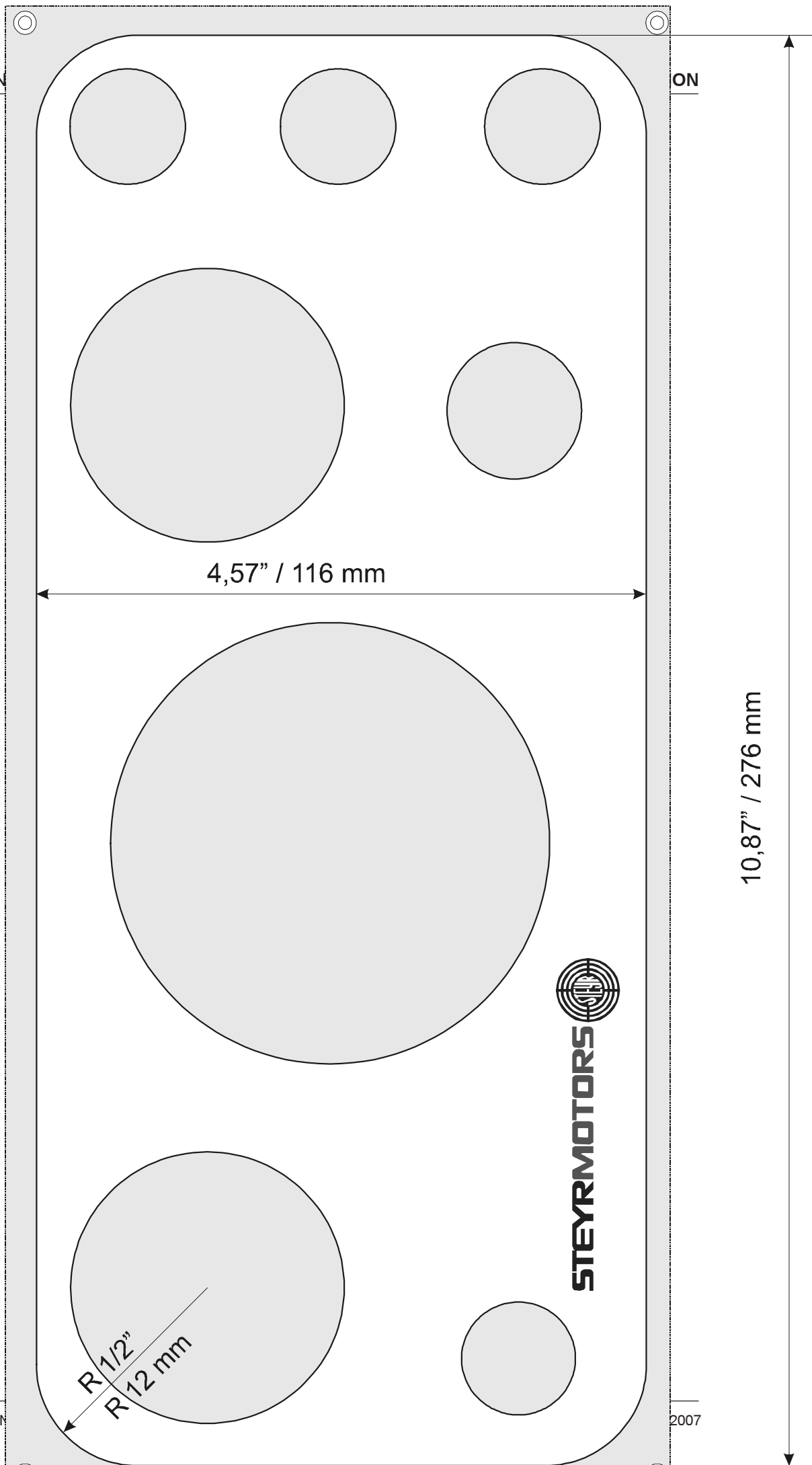
15.6.2 Scheme for instrument panel and SCC



ill. 15/11

NOTE: Oil pressure sender for twin installation must be changed.

15.6.3 Cut out drawing for "STANDARD Instrument Panel"

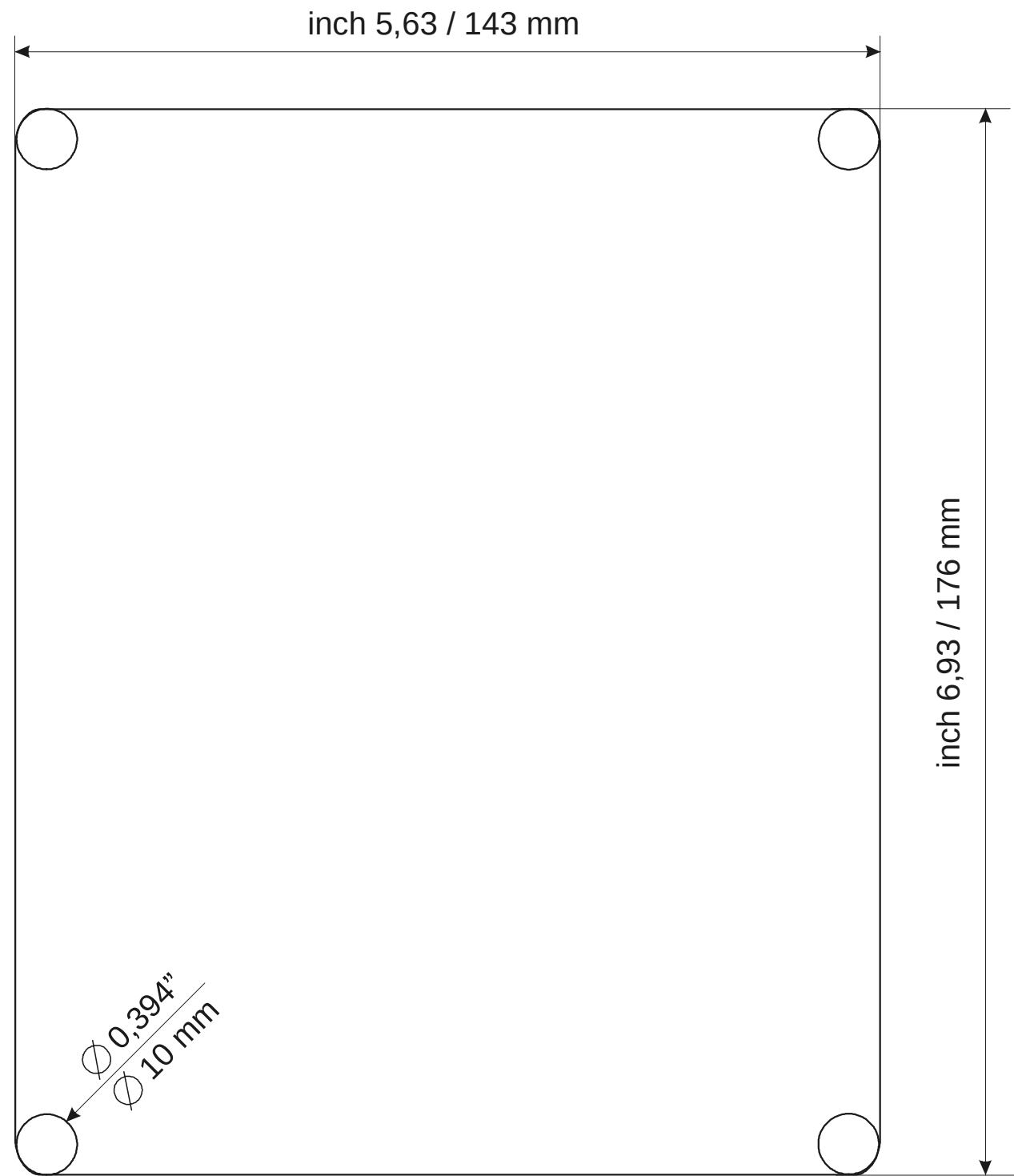


15.6.4 Cut out drawing for "SOLAS Instrument Panel"



ill. 15/13

15.6.5 Cut out drawing for SCC



16. ELECTRICAL EQUIPMENT

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16. 6. CABLE CROSS-SECTION	6

16. ELECTRICAL EQUIPMENT

NOTES

16. ELECTRICAL EQUIPMENT

16. 1. GENERAL

Cable laying is to be planned and carried out precisely and carefully. Cables must be approved for marine operation. Pull the cables through appropriate protective sleeves to be fixed properly. Make sure that cables are not too close to hot parts of the engine. Cables must not be exposed to mechanical wear and mechanical abrasion. If necessary, pull the cables through protection tubes.

Attention: Never fix a cable in such a way that it could lay in bilge water.

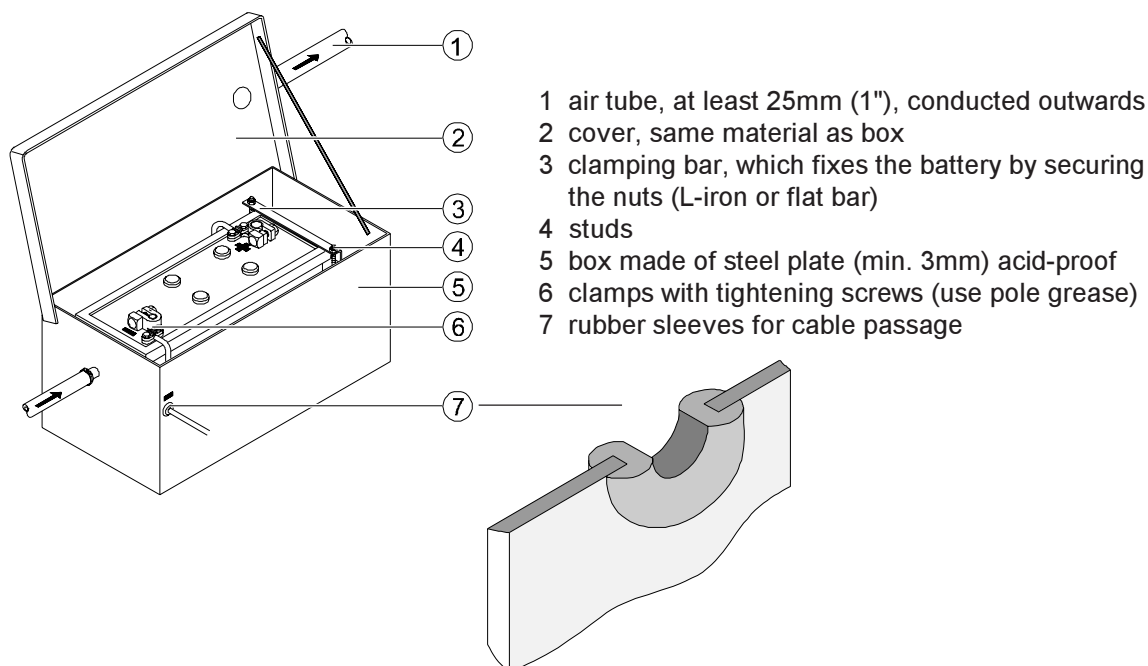
16. 2. BATTERIES

Install the batteries in a battery box situated low in the boat to avoid leaking of battery acid due to motion of the sea. Provide easy access to the box for servicing the batteries, as well as proper ventilation, as the batteries generate small amounts of explosive gas.

Install main switches at the positive and negative side. In case of one single switch, install it easily accessible at the positive side.

Required capacity of main switches:
min. 1000A (short-circuit current)

Attention: Only bipolar systems may be installed otherwise galvanic streams may occur which cause corrosion.



4 Cyl. Engine	6 Cyl. Engine
rated capacity: 12V / 92 Ah cold test current: 450 A	rated capacity: 12V / 115 Ah for 24V installation: 2 x 12V/ 115 AH cold test current: 650 A

16. 3. BATTERY CABLE LENGTHS AND CROSS-SECTIONS

Determine the length of the positive cable from the positive pole (+) of the battery to connection No. 30 at the starter.

Total length is the sum of cable length of positive cable (+) and earth cable (-).

For example:

positive cable = 3,0 m
ground cable = 2,0 m

Total length = 5,0 m ==> cable cross section = 70 mm²

For ground connection, determine corresponding cross-sections as per chart.

For 4 cyl. engines only

starter engine: 2 kW - 12 volt battery size: 92 AH		
length in m	cable cross-section in mm ²	AWG
0,0 - 4,0	50	0
4,1 - 5,0	70	00
5,1 - 6,0	95	0000

For 6 cyl. engines only

starter engine: 3 kW - 12 Volt battery size: 110 AH		
length in m	cable cross-section in mm ²	AWG
0,0 - 3,0	50	0
3,1 - 4,5	70	00
4,6 - 5,5	95	0000

In general, take care that battery cable lengths are kept as short as possible.

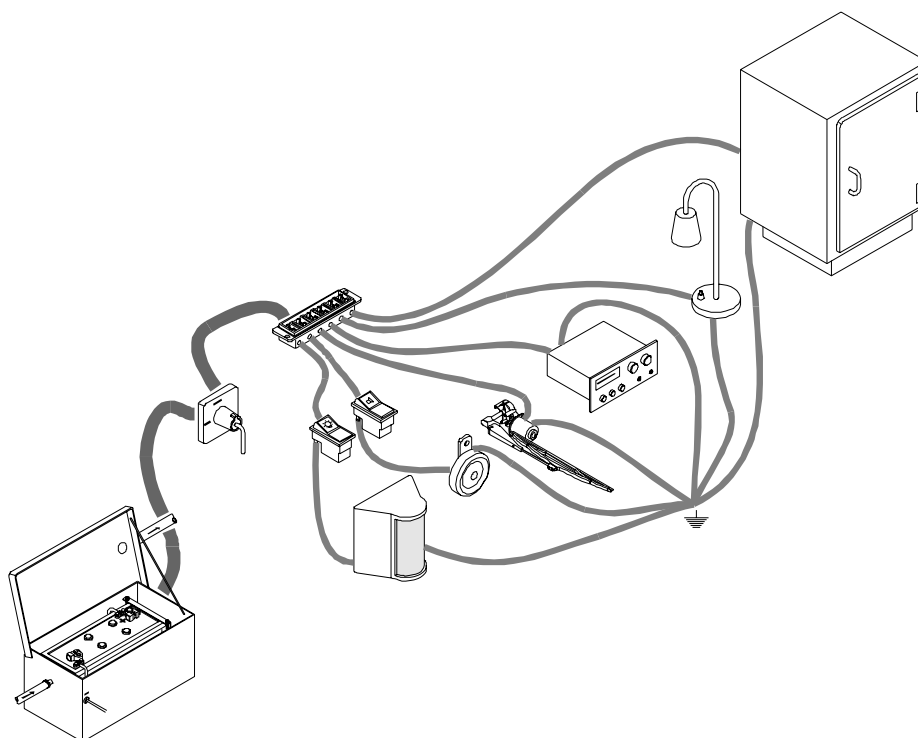
16. 4. ADDITIONAL CURRENT UTILIZATION DEVICES

Before connecting an additional current utilization device, such as lighting, radio, echo-sounder etc., first calculate the total power consumption of all these components to guarantee sufficient capacity of the dynamos.

Example: When using a 50A dynamo you may connect current utilization devices consuming all together 50A simultaneously. In case of a too small capacity of the dynamo a larger or an additional dynamo may be installed. Since the starting quality of the battery must be guaranteed max. 90 % (45A) of the rated capacity may be consumed simultaneously and permanently.



ELECTRICAL EQUIPMENT OF THE ENGINE PERMANENTLY REQUIRES APPROX. 15 A.



16. 5. CALCULATION OF CABLE CROSS-SECTION FOR ADDITIONAL EQUIPMENT

Use this table to find the cable cross-section required for a specific power requirement.

Example: A current-utilization device (24V) of 300 watt is to be installed. In this case distance from the current-utilization device to the battery is four meters. Required cable length is 8 meters, since cable length back and forth is to be considered.

In the table a straight line is drawn from 8 in the length (m) column sloping downwards to 300 in the power column. This straight line crosses the cross-sectional column at 4,5. Therefore, a cable with a cross-section of 4,5 mm² min. is to be used. This value is rounded up to the next cable size available.

12 Volt			24 Volt		
length in m	cross-section in mm ²	amp watt	length in m	cross-section in mm ²	amp watt
25		700	25		4000
	70	50		120	150
20	50	40	20	95	3000
	35			70	
15	25	30	15	50	1000
	16			35	80
10	10	20	10	25	60
	6	15		16	50
8		200	8	10	40
	4	150		6	30
6	2,5	10	6	4	20
	1,5	8		2,5	15
5	1	6	5	1,5	10
	0,75	5		1	8
4		4	4	0,75	6
	0,5	3			5
3		3	3		4
		2			3
2		2	2		2
		1			1
1,5		1	1,5		1
		0,5			0,5
1		0,5	1		0,5
		0,2			0,2
0,8		0,2	0,8		0,2

16. 6. CABLE-CROSS SECTION

The cable cross-section is determined by the rated current of the fuse.

Rule of thumb for dimensioning: a maximum of 10 A per mm²

17. DRILL TEMPLATES

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STERN DRIVE VOLVO	11
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STERN DRIVE VOLVO DP 290	13
--------------------------------	----

STERN DRIVE	15
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STERN DRIVE BRAVO	17
-------------------------	----

JET-DRIVE CASTOLDI	19
--------------------------	----

JETDRIVE CASTOLDI	21
-------------------------	----

JETDRIVE CASTOLDI	23
-------------------------	----

6 Cyl. Marine Engine

FRONT VIEW	25
------------------	----

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---------------	----

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------------------	----

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----------------------	----

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JET-DRIVE CASTOLDI	37
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STERN DRIVE MERCURY BRAVO II & III	39
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STERN DRIVE VOLVO DP 290	41
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17. DRILL TEMPLATES

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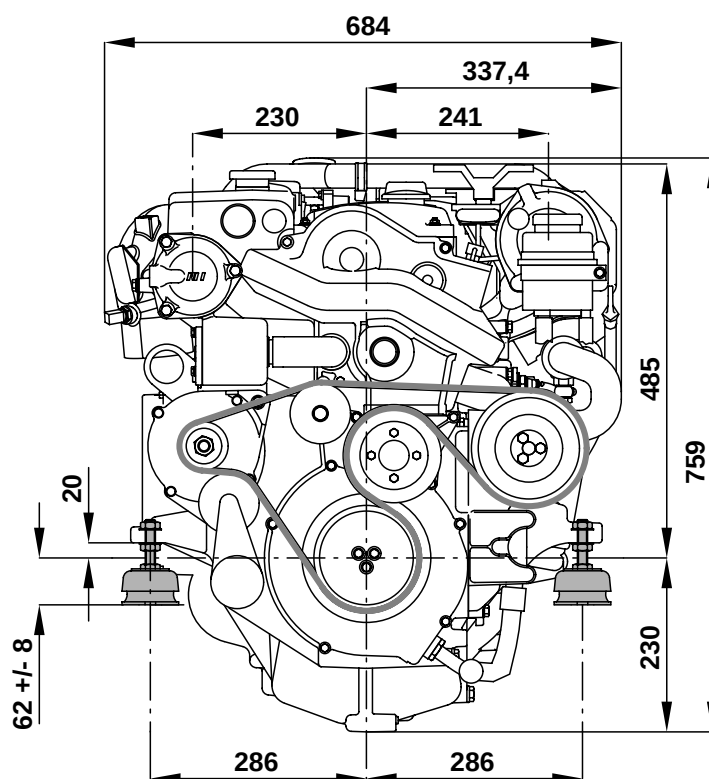
6 Cyl. Marine Engine

STERN DRIVE VOLVO DP 290 ZF	45
STERN DRIVE SX-DRIVE OMC	47
TUNNELDRIVE SARO	49

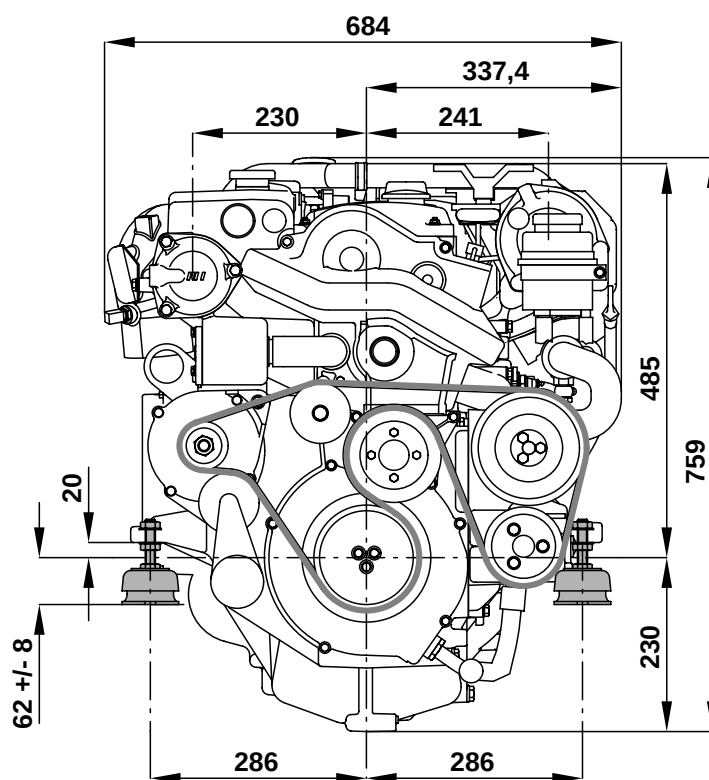
Drill templates (scale approx. 1:10)

4 Cyl. Marine Engine

Front view



without hydraulic pump



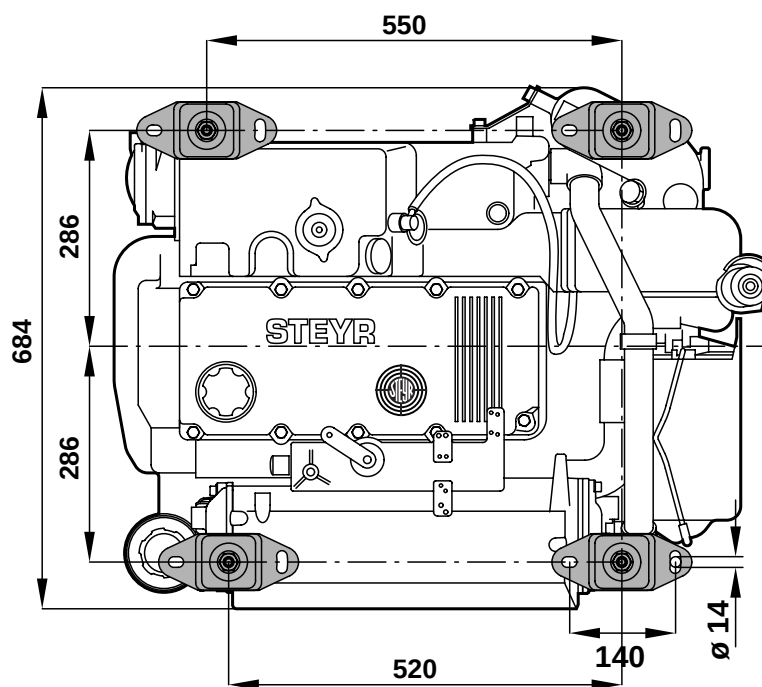
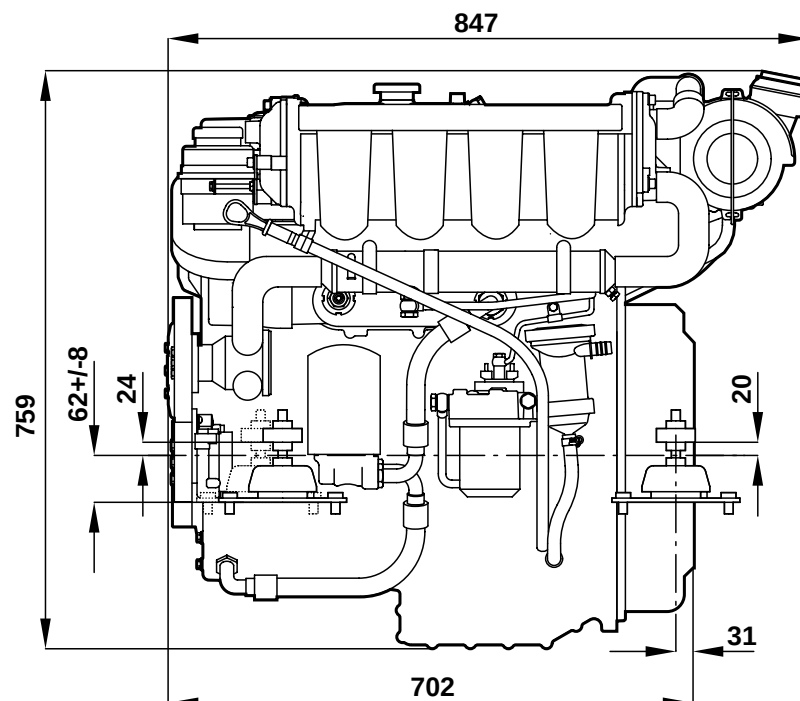
with hydraulic pump

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Drill templates (scale approx. 1:10)

4 Cyl. Marine Engine

Bobtail - without coupling



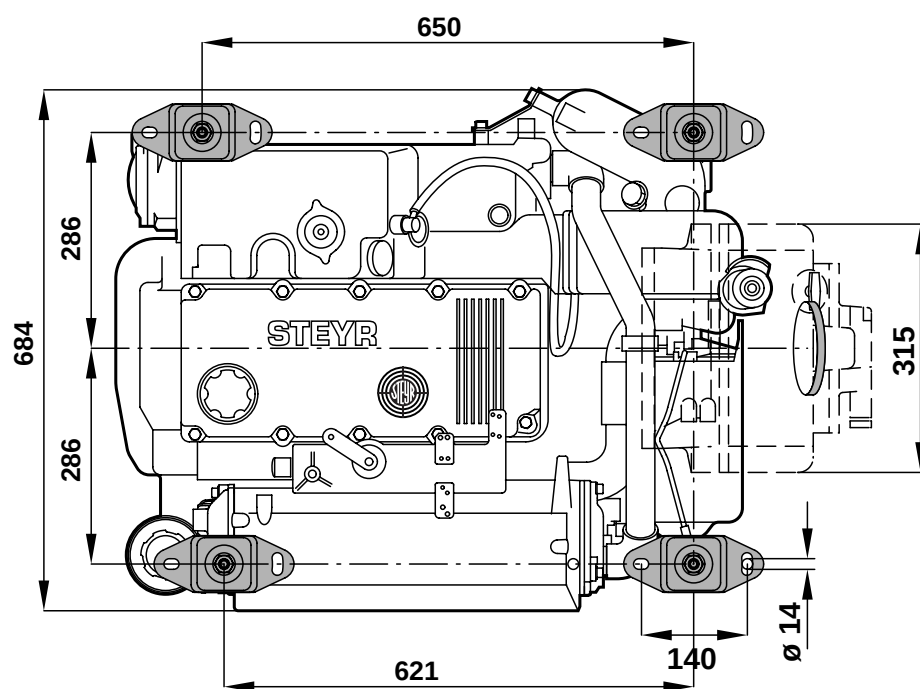
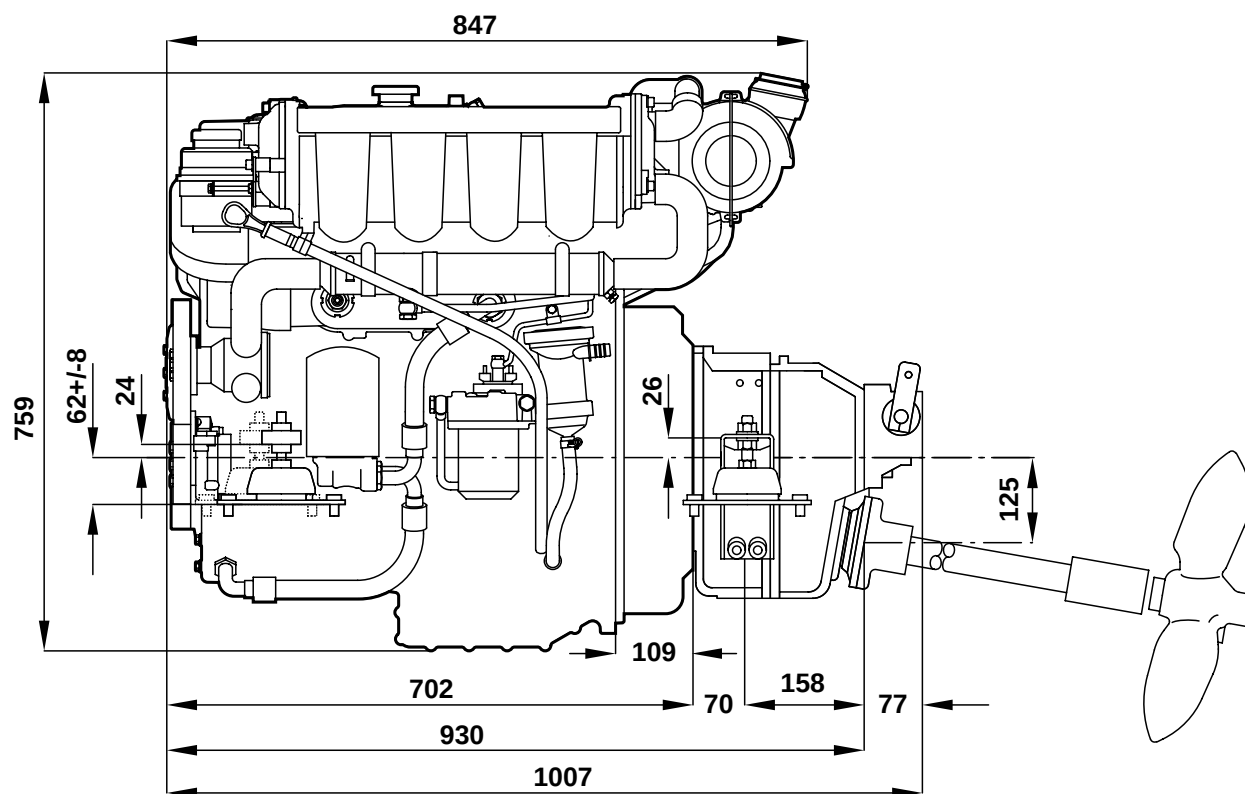
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Drill templates (scale approx. 1:10)

4 Cyl. Marine Engine

Inboard with ZF 45A marine gear

Down angle 8°

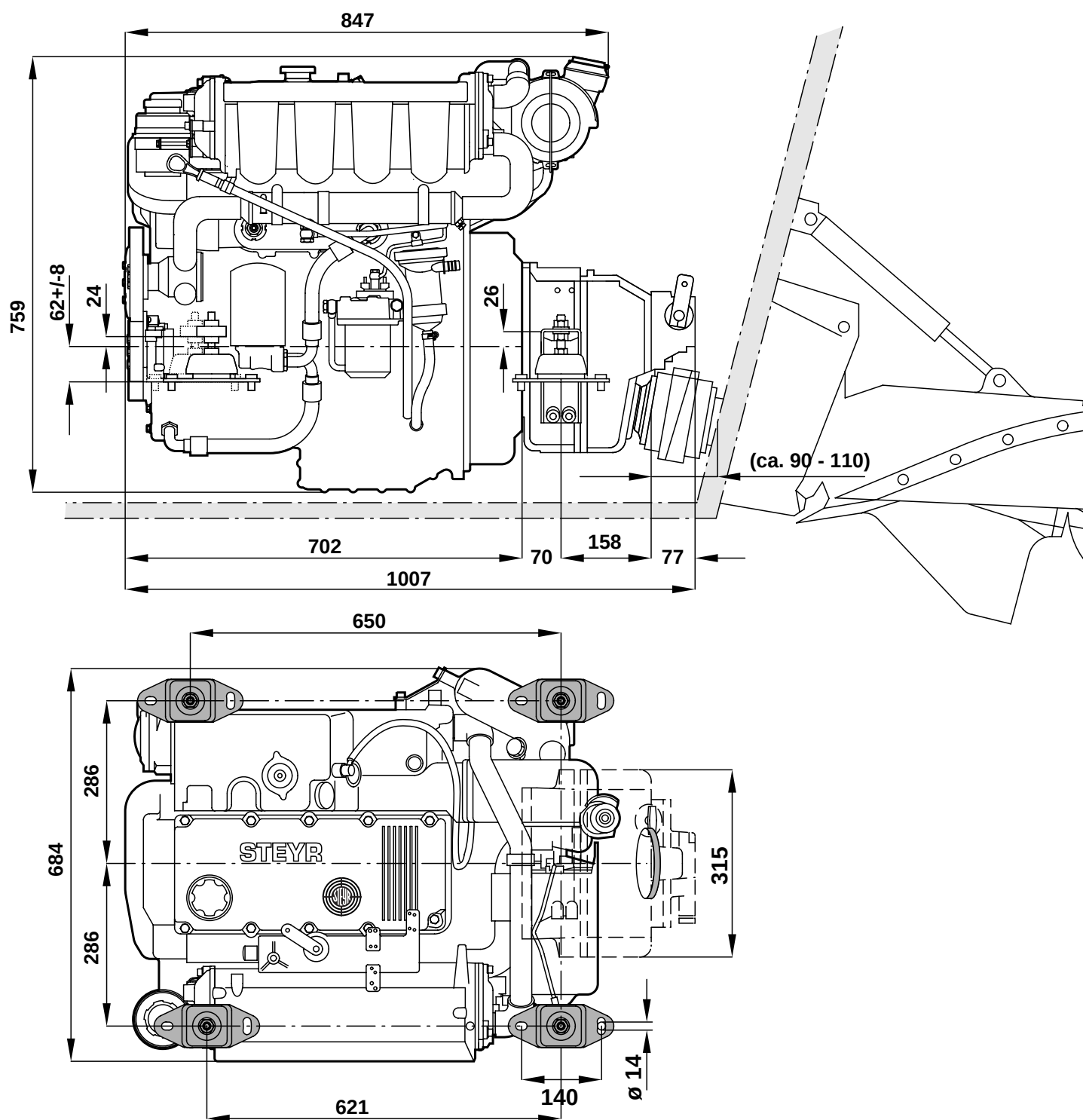


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Drill templates (scale approx. 1:10)

4 Cyl. Marine Engine

Tunnel Drive SARO

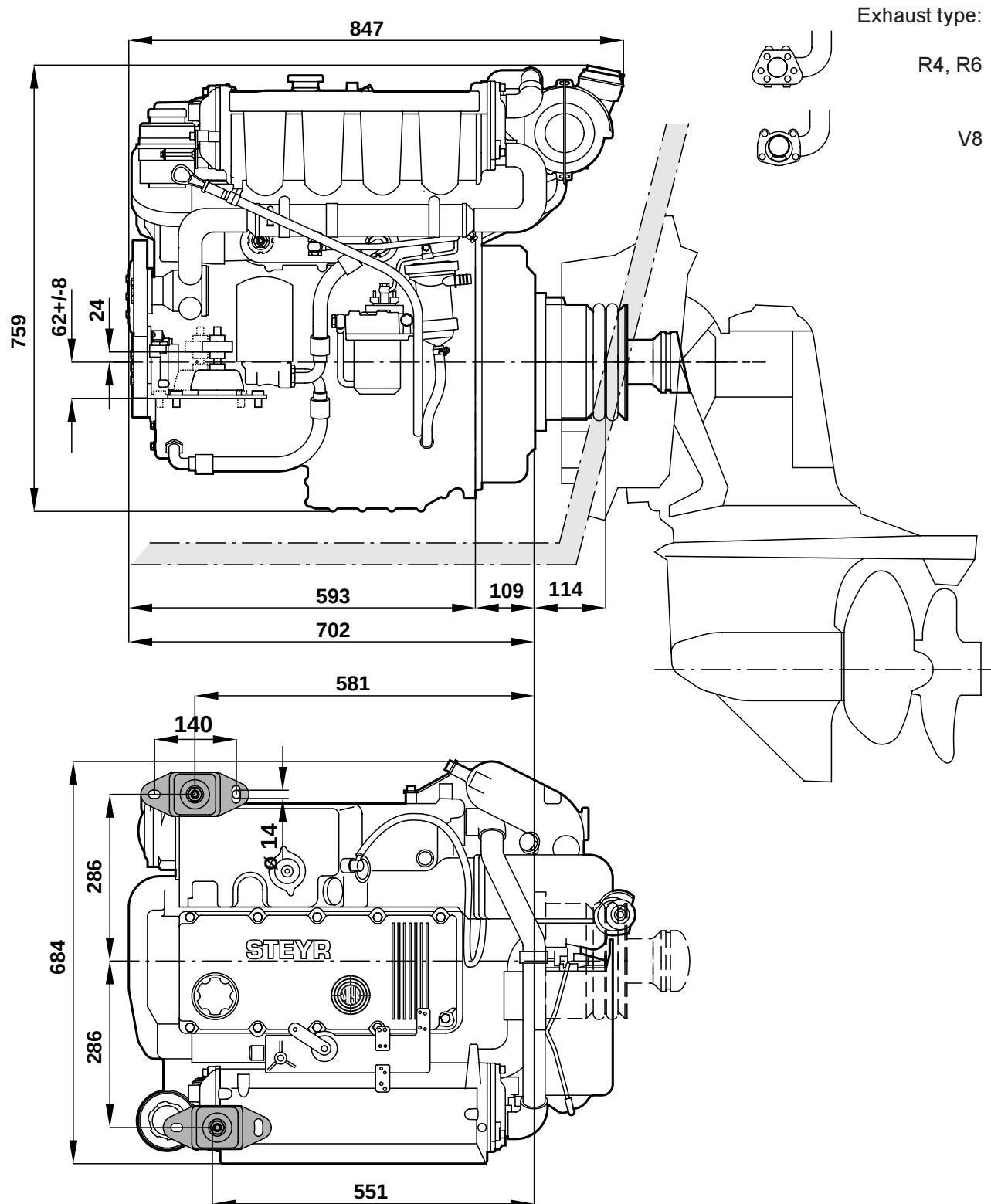


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Drill templates (scale approx. 1:10)

4 Cyl. Marine Engine

Stern - Drive VOLVO DP 290 Hydraulic



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Drill templates (scale approx. 1:10)

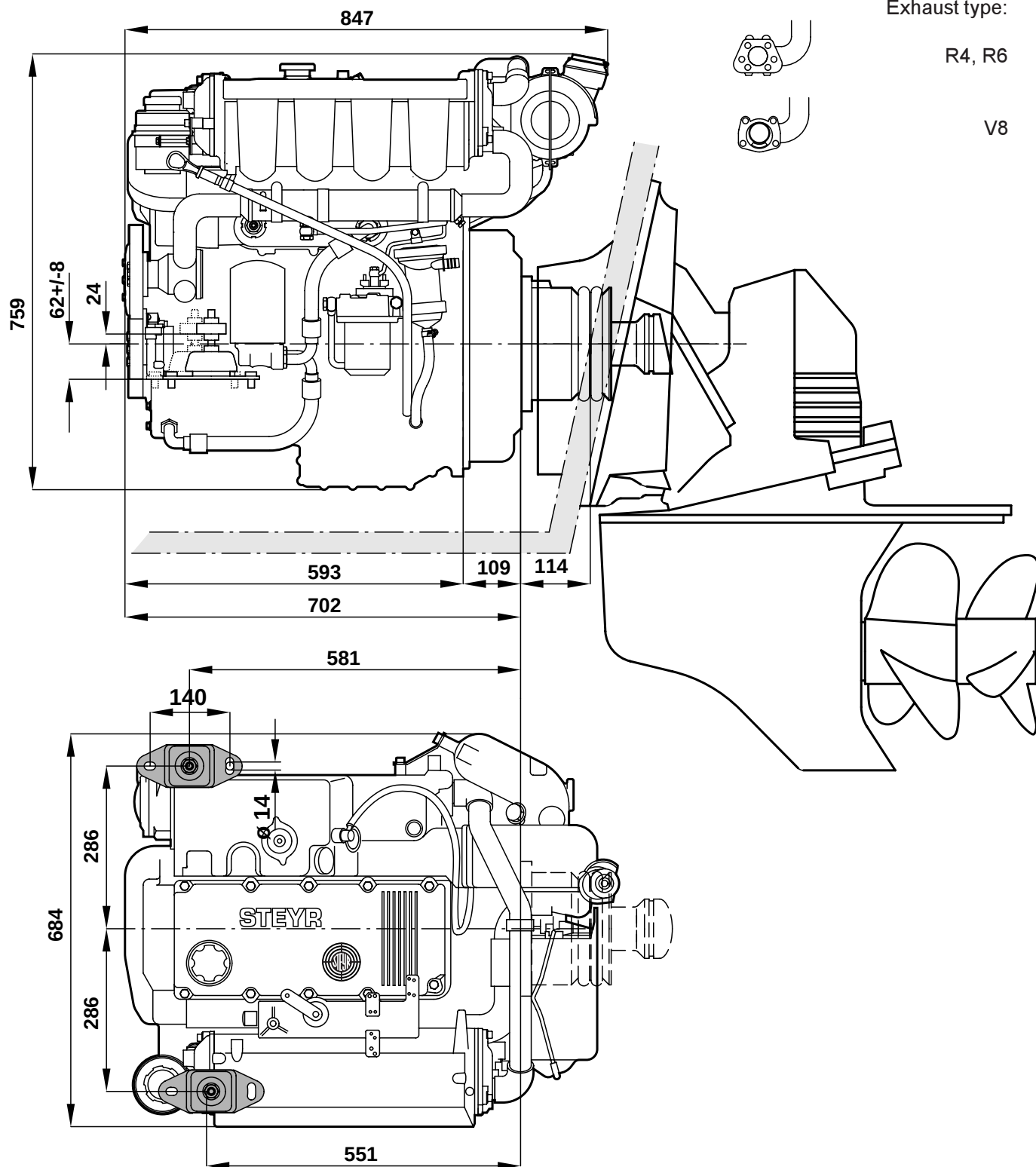
4 Cyl. Marine Engine

Stern - Drive VOLVO DP 290

Exhaust type:

R4, R6

V8

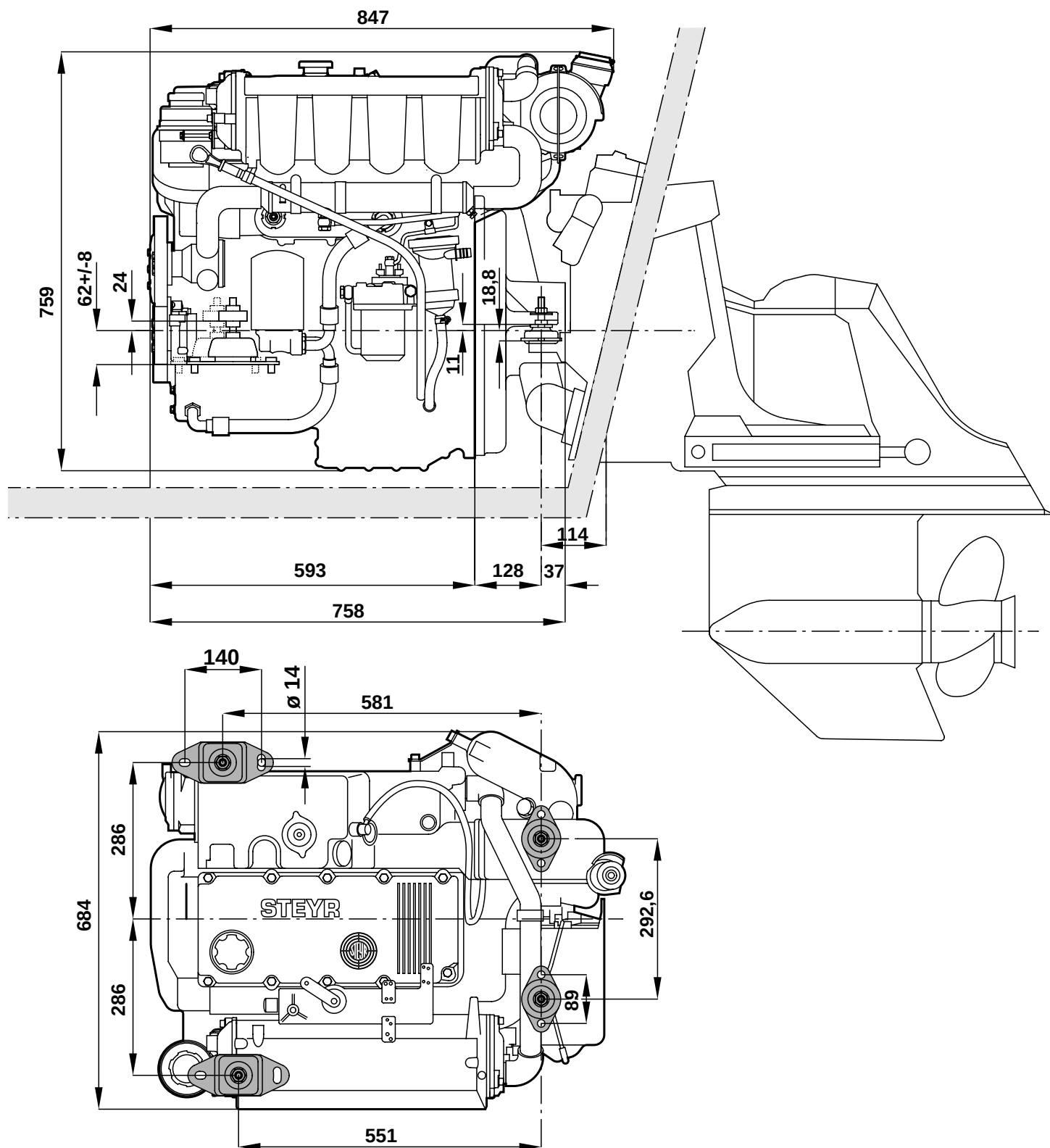


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Drill templates (scale approx. 1:10)

4 Cyl. Marine Engine

SX Stern - Drive

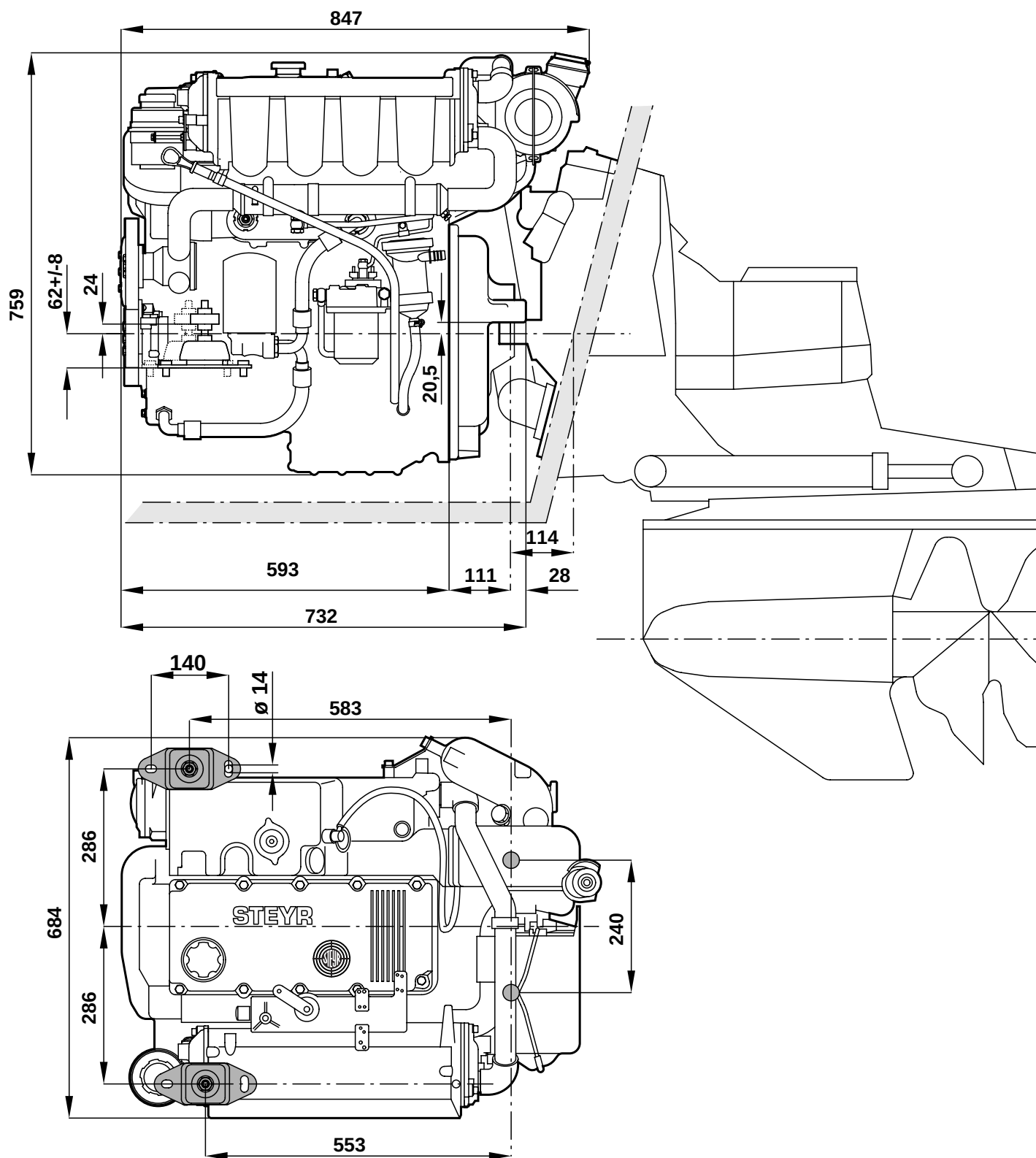


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4 Cyl. Marine Engine

MERCURY ALPHA BRAVO II & III

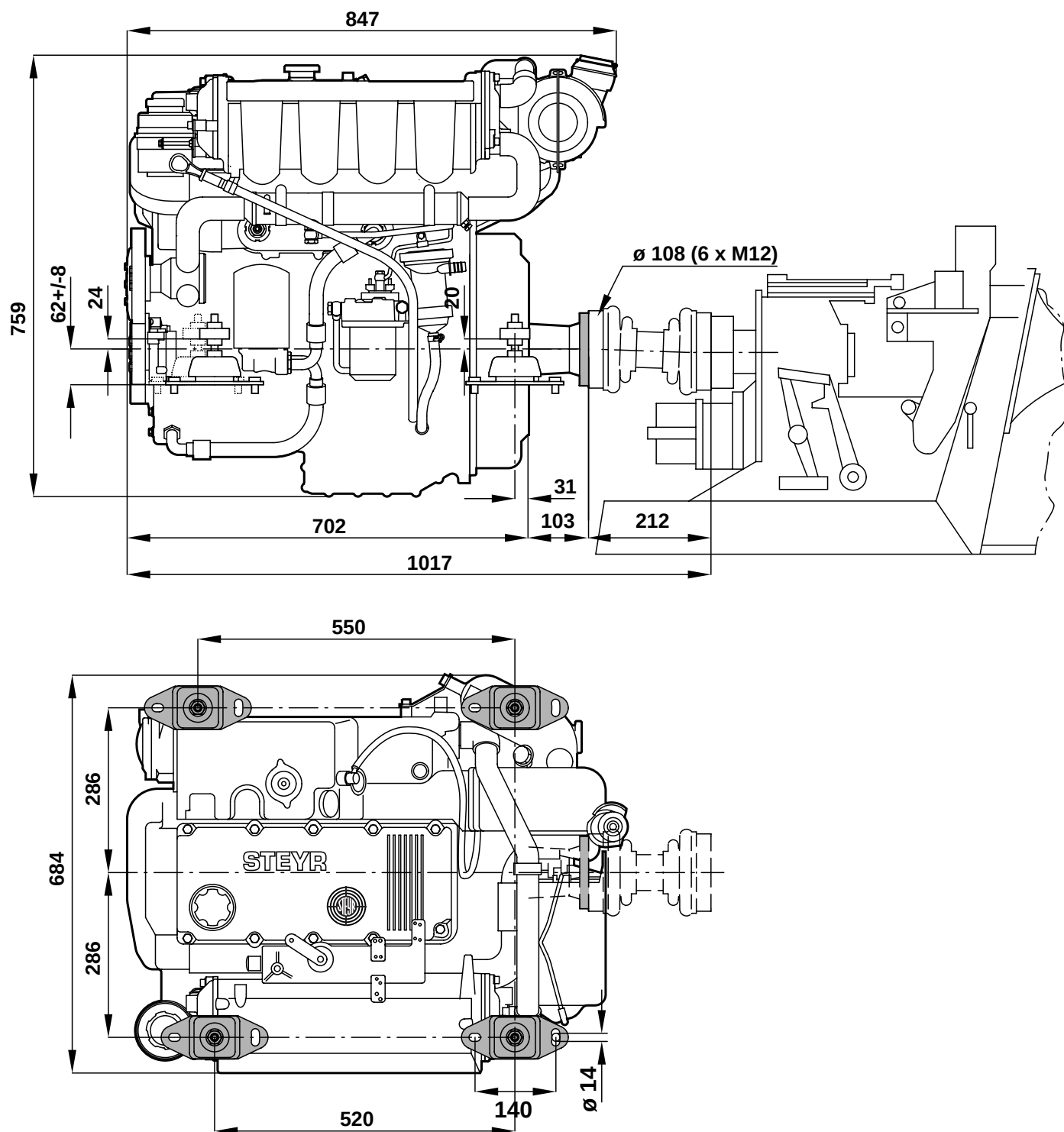


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4 Cyl. Marine Engine

Jet - Drive CASTOLDI

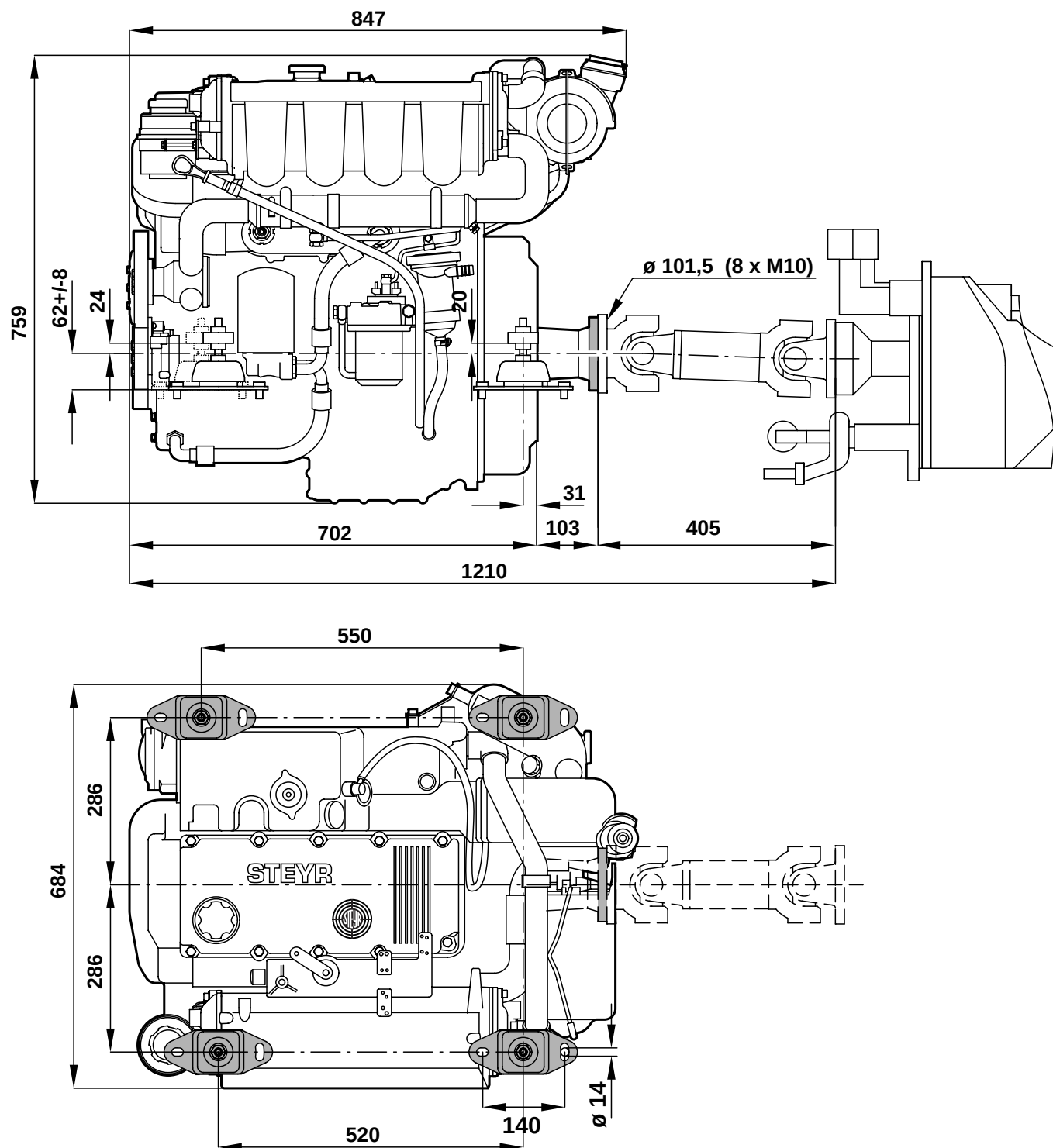


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4 Cyl. Marine Engine

Jet - Drive CASTOLDI

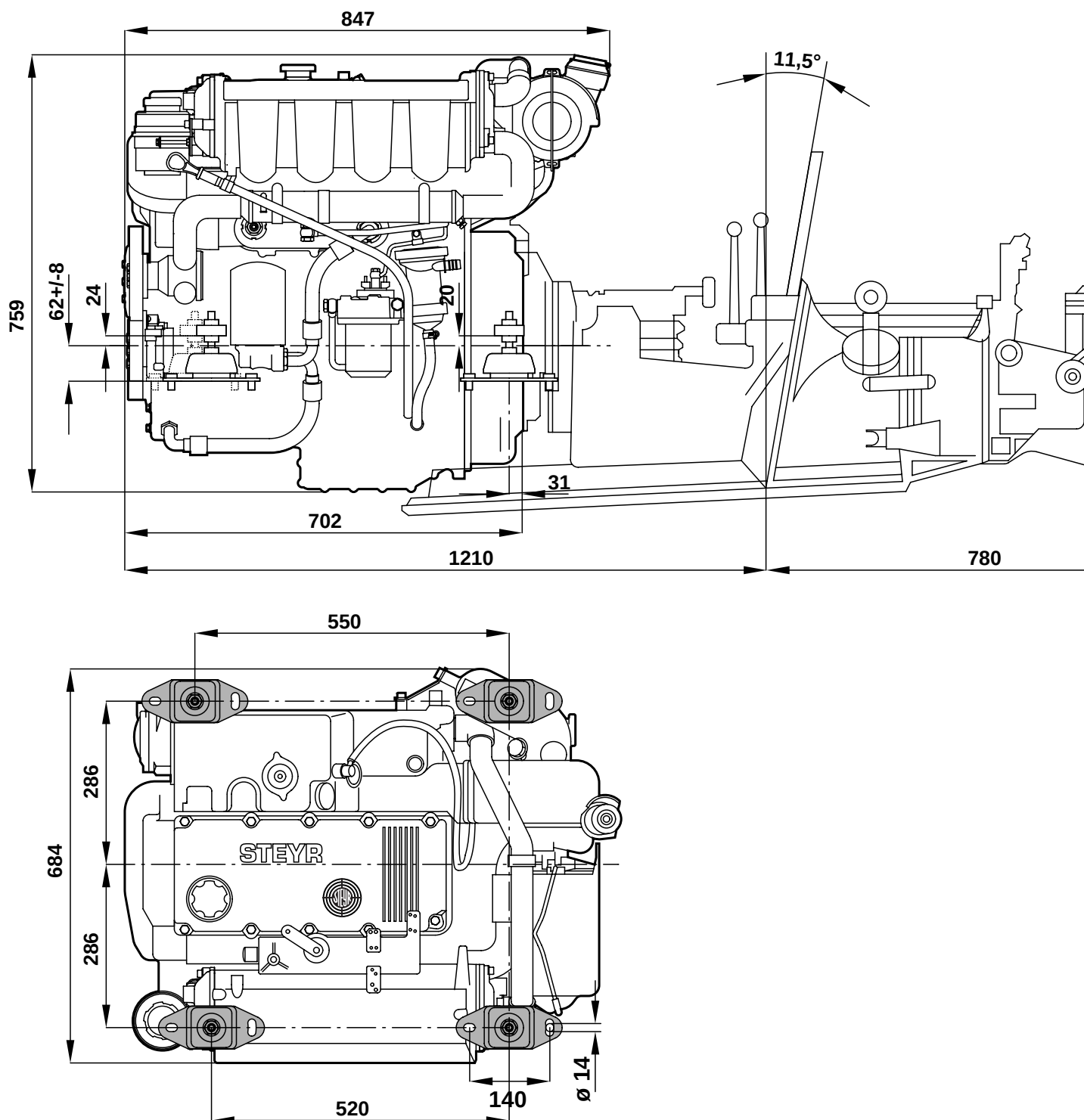


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4 Cyl. Marine Engine

Jet - Drive CASTOLDI 05

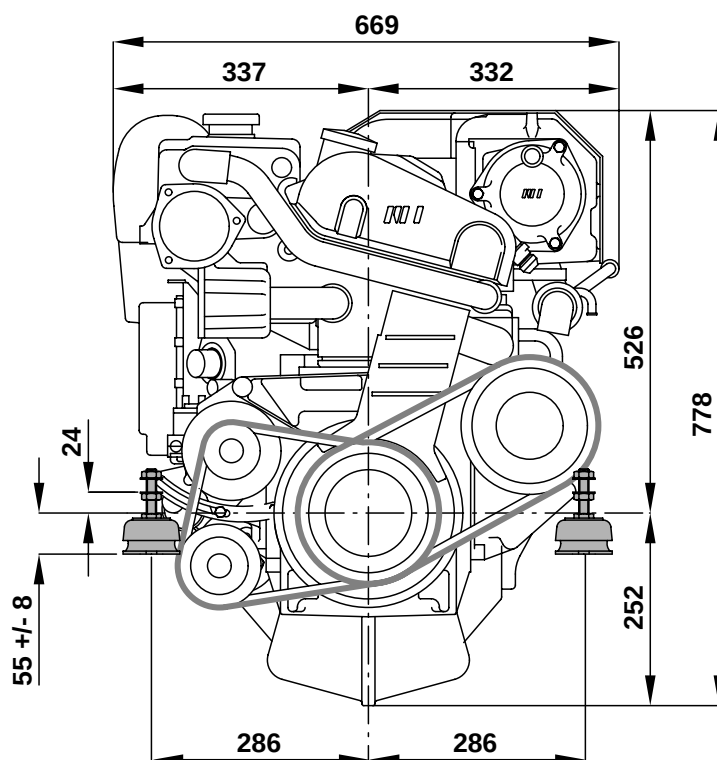


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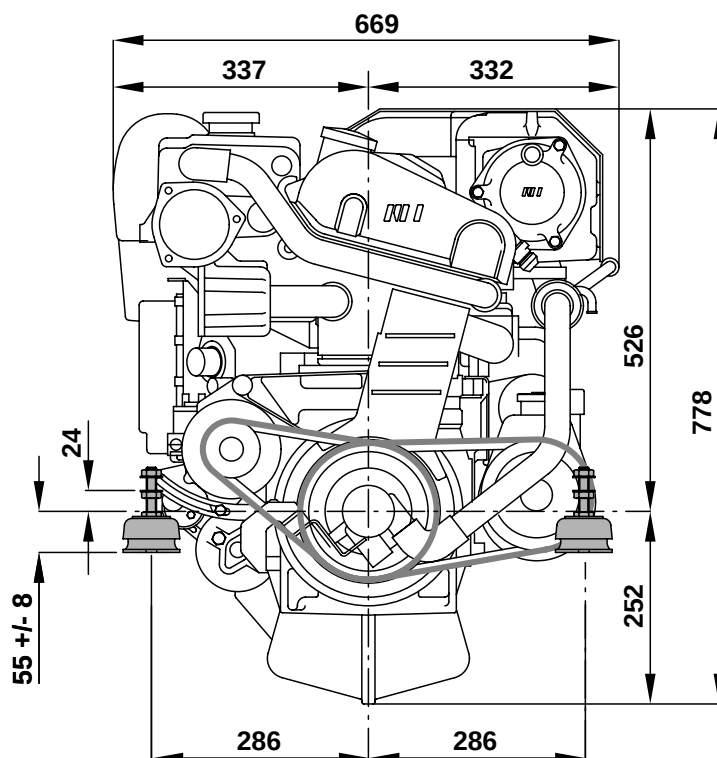
Drill templates (scale approx. 1:10)

6 Cyl. Marine Engine

Front view



with hydraulic pump



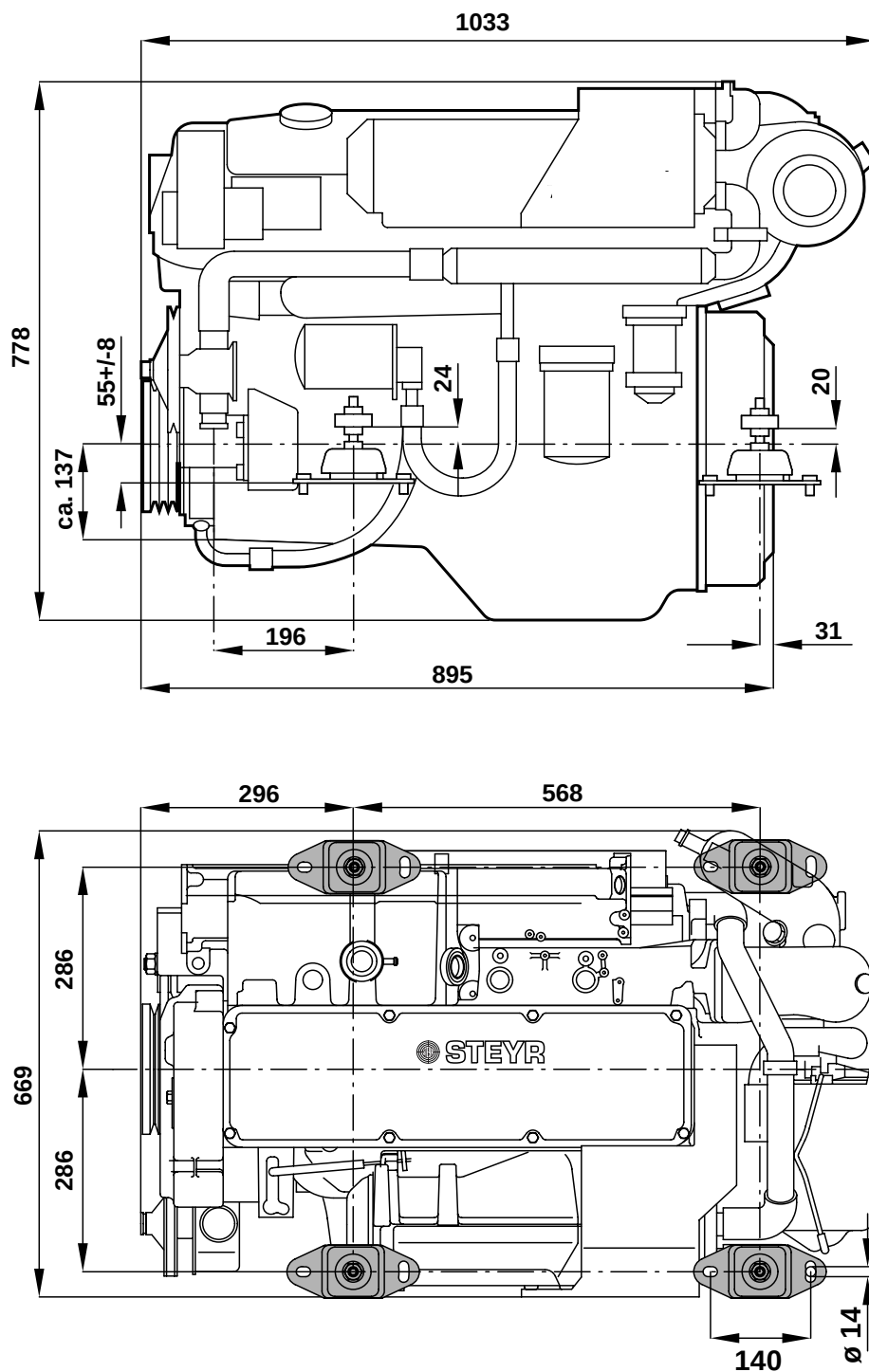
without hydraulic
pump

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Drill templates (scale approx. 1:10)

6 Cyl. Marine Engine

Bobtail



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6 Cyl. Marine Engine

**Inboard with ZF 63A marine gear
Down Angle 8°**

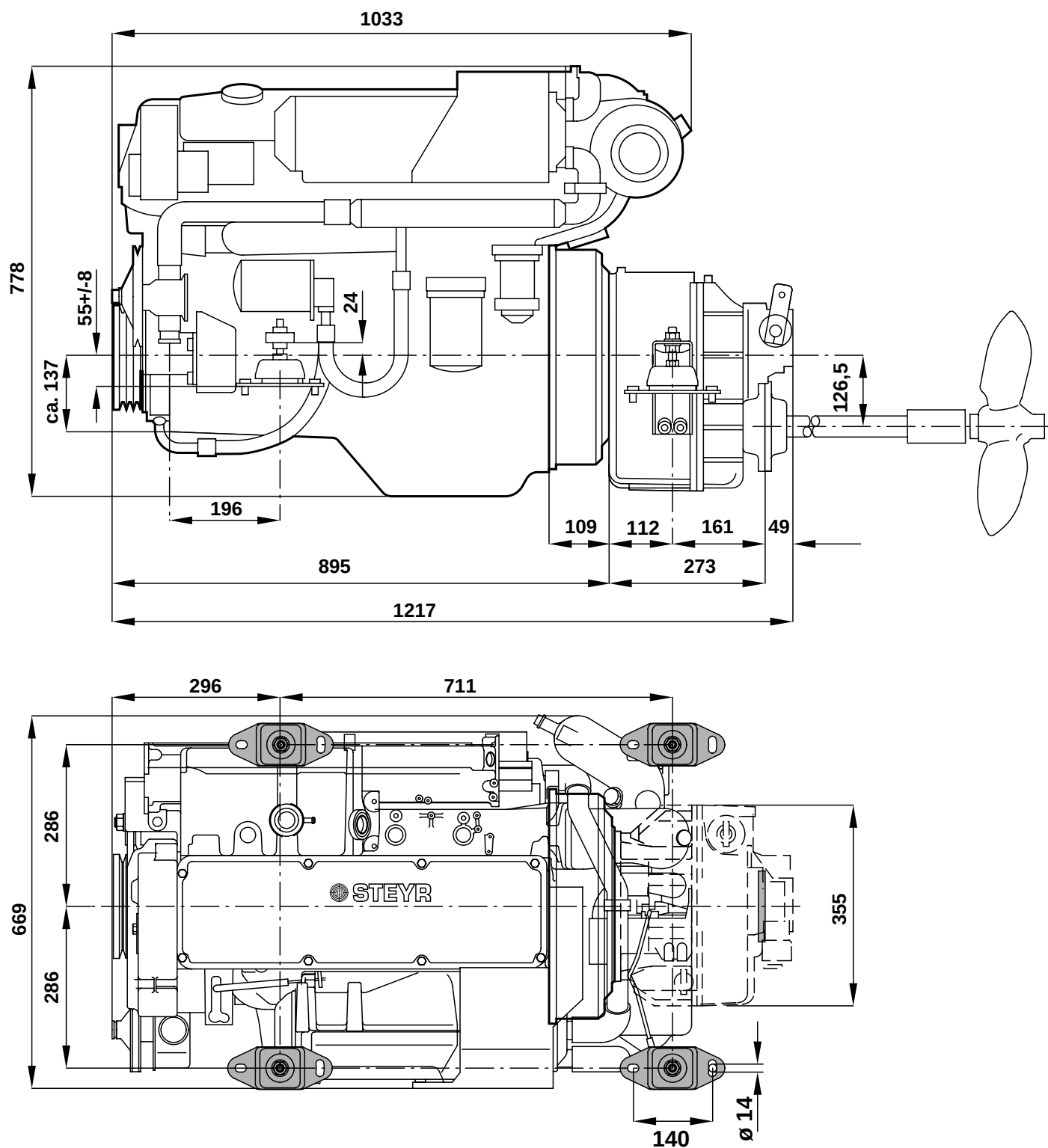


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Drill templates (scale approx. 1:10)

6 Cyl. Marine Engine

Inboard with ZF 63 marine gear
Straight Shaft

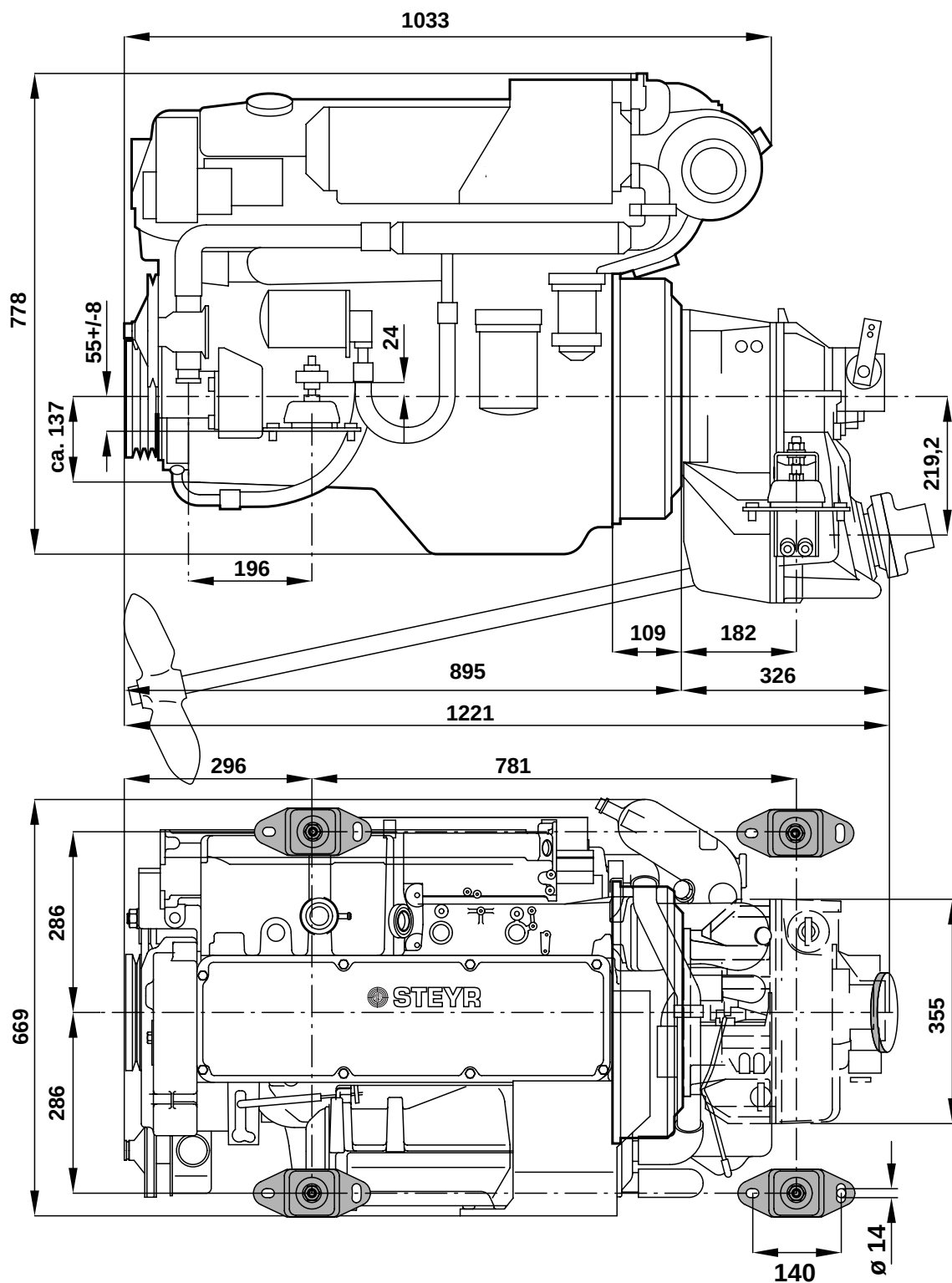


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6 Cyl. Marine Engine

Inboard with ZF IV marine gear
V - Drive 12°

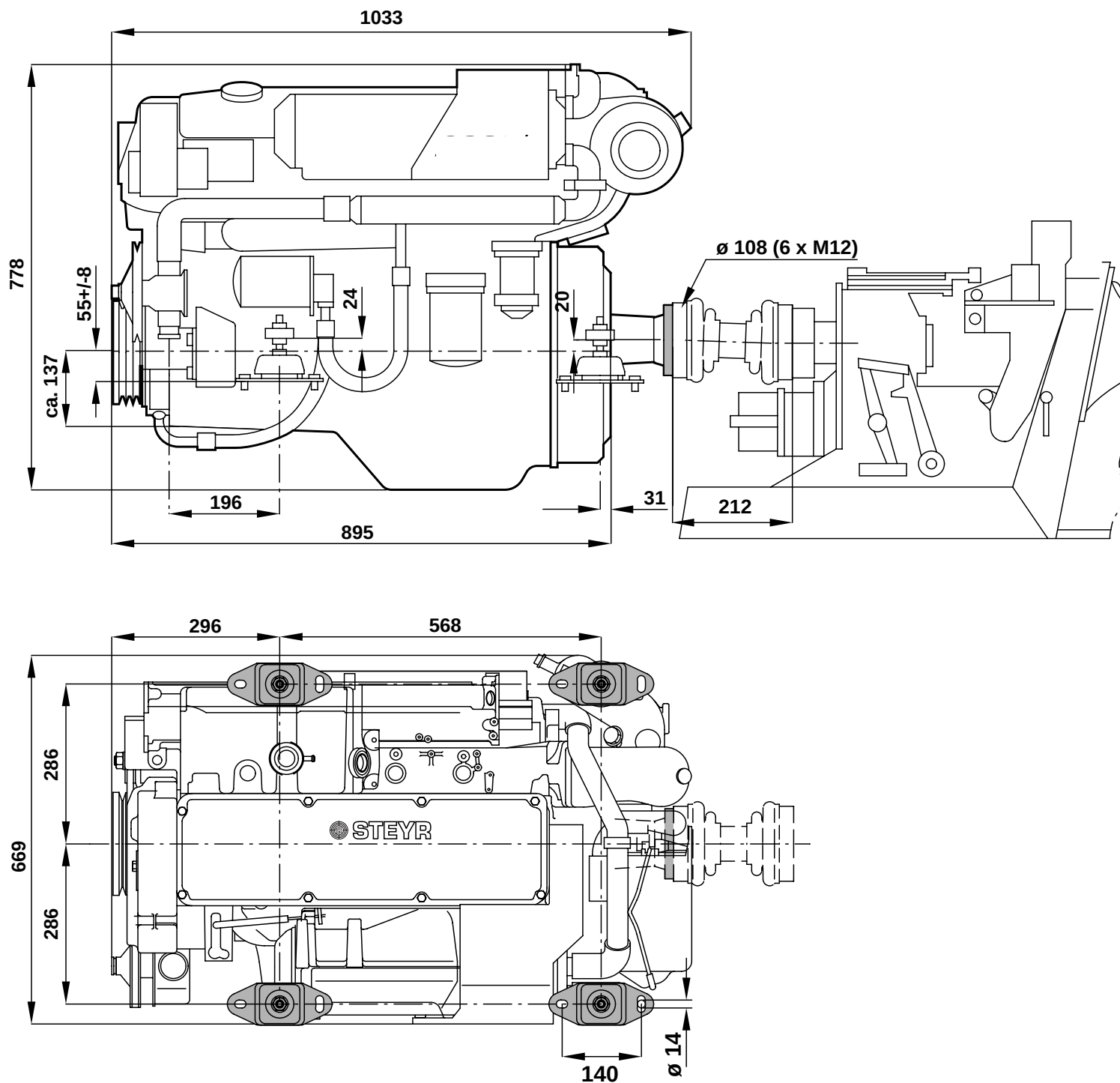


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6 Cyl. Marine Engine

Jet - Drive CASTOLDI

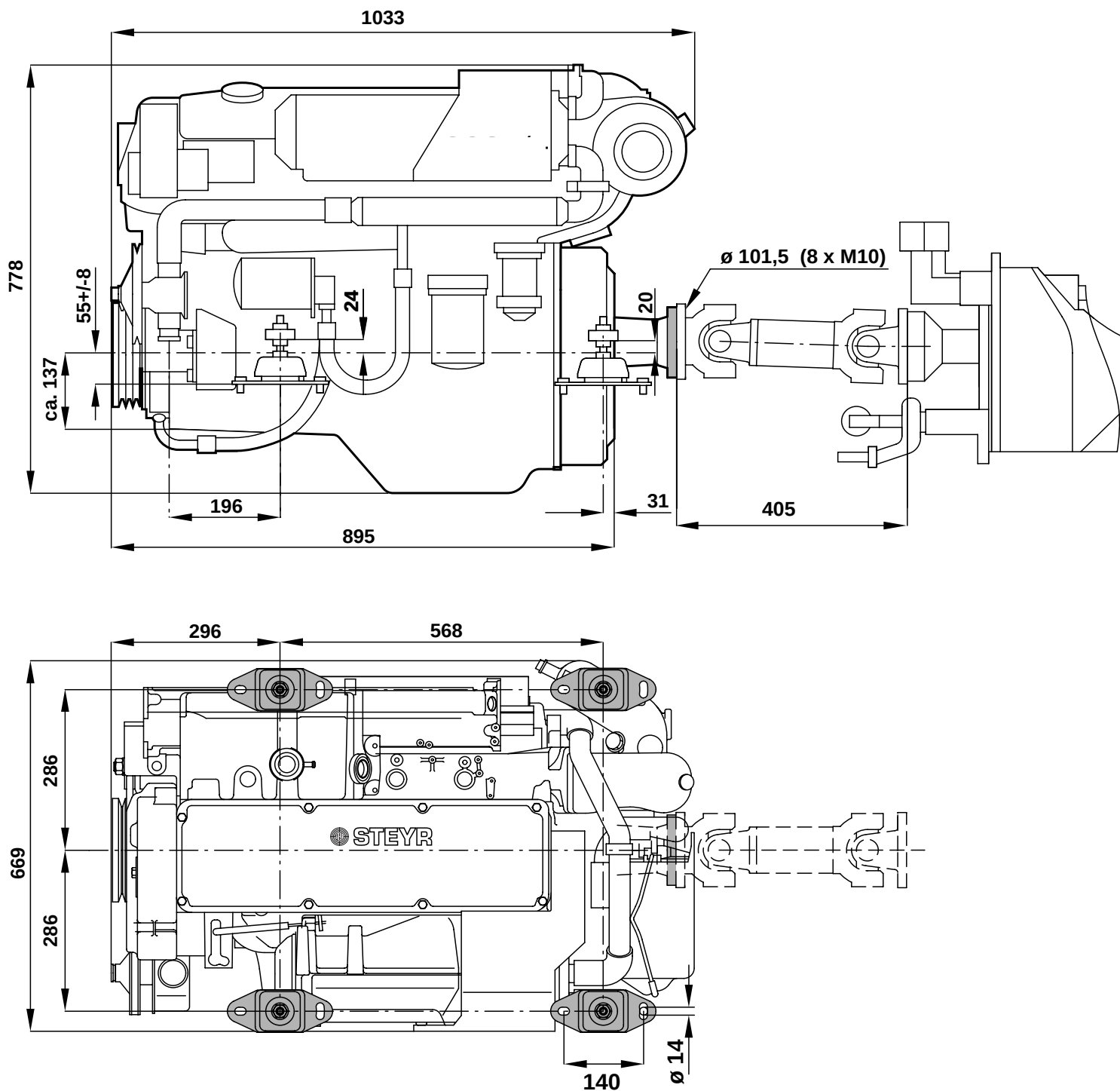


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6 Cyl. Marine Engine

Jet - Drive CASTOLDI

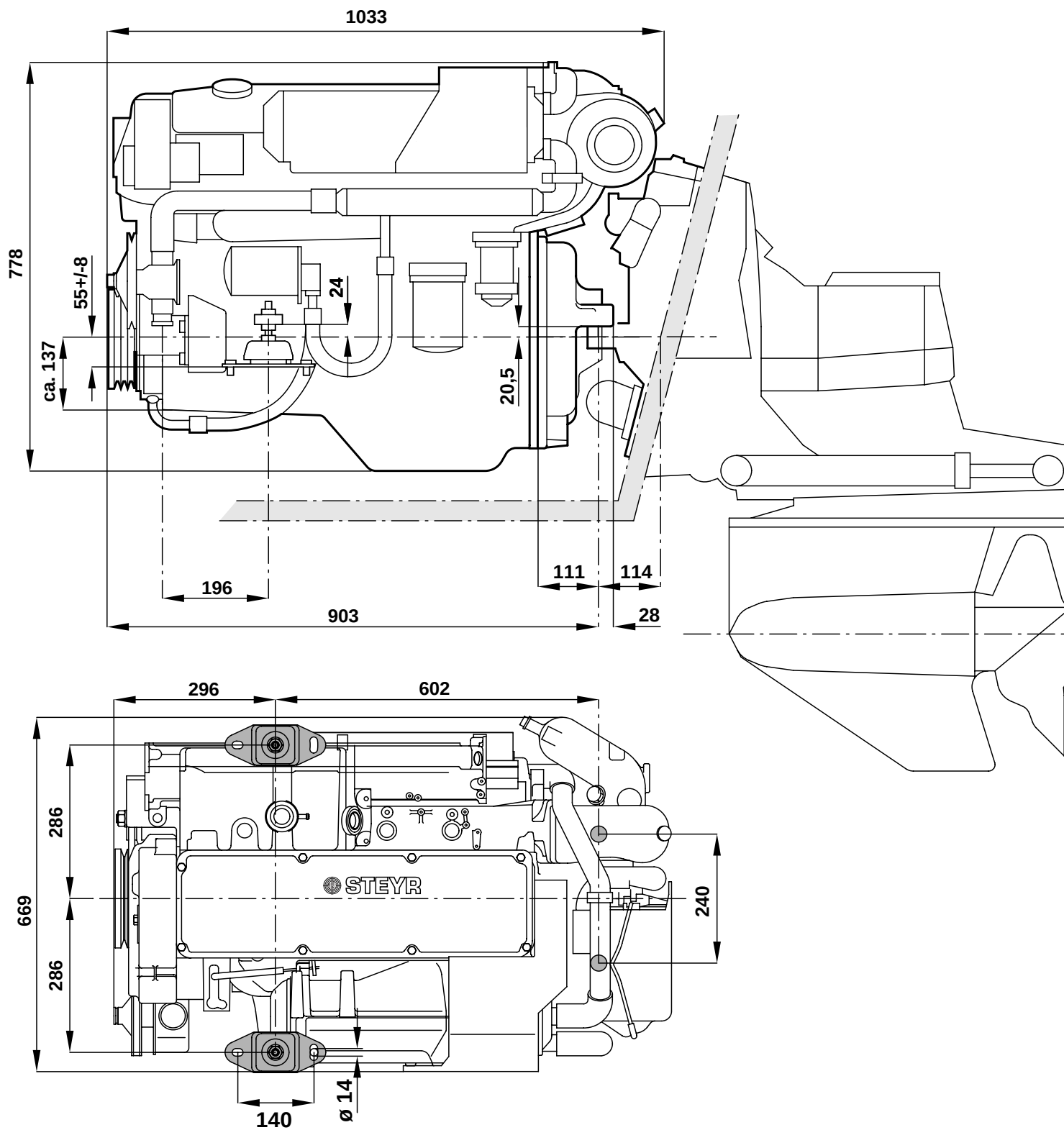


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Drill templates (scale approx. 1:10)

6 Cyl. Marine Engine

Stern - Drive MERCURY BRAVO II & III

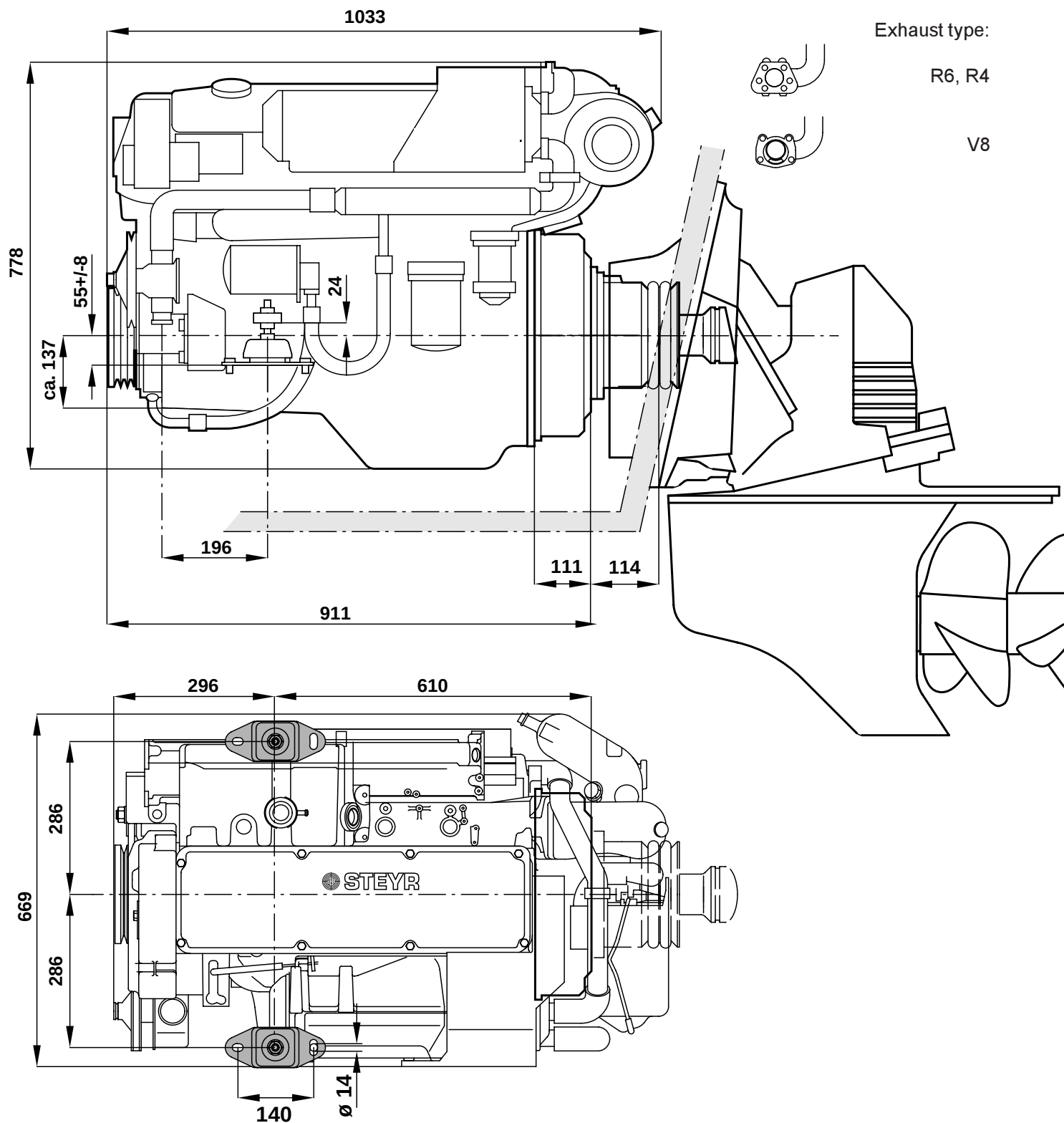


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Drill templates (scale approx. 1:10)

6 Cyl. Marine Engine

Stern - Drive VOLVO DP 290

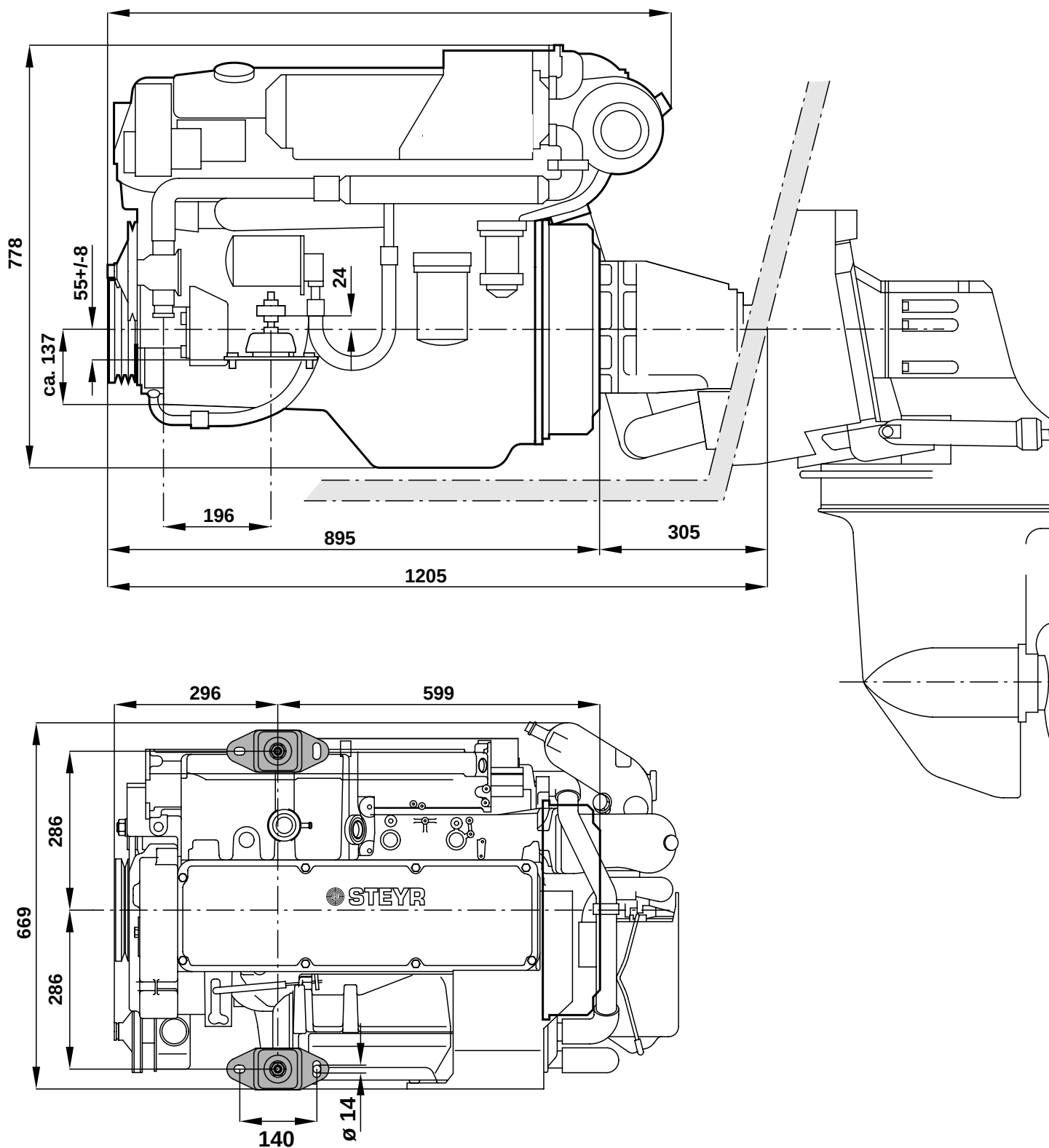


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6 Cyl. Marine Engine

Stern - Drive STERN POWER S1000

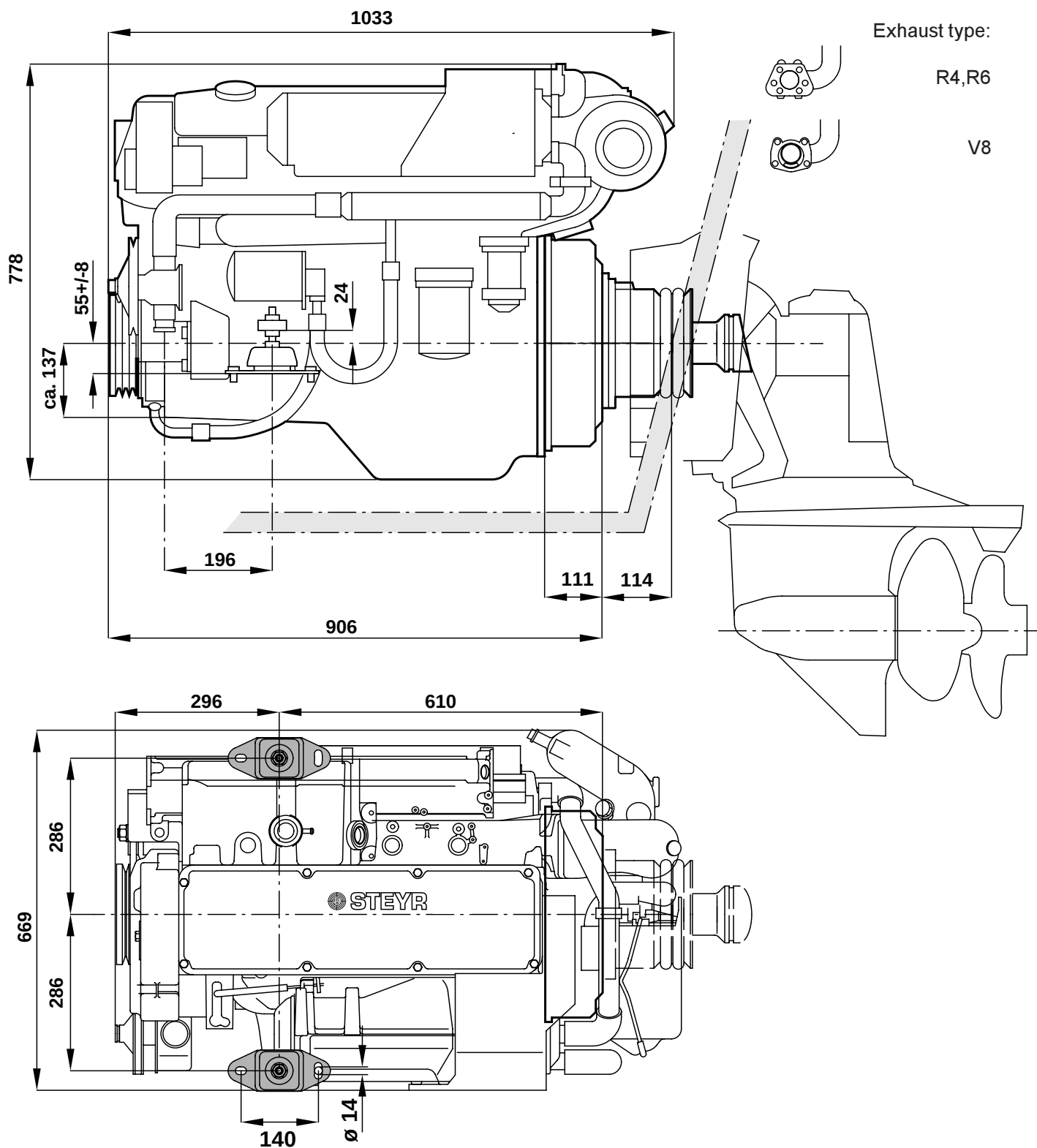


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6 Cyl. Marine Engine

Stern - Drive VOLVO DP 290 Hydraulic

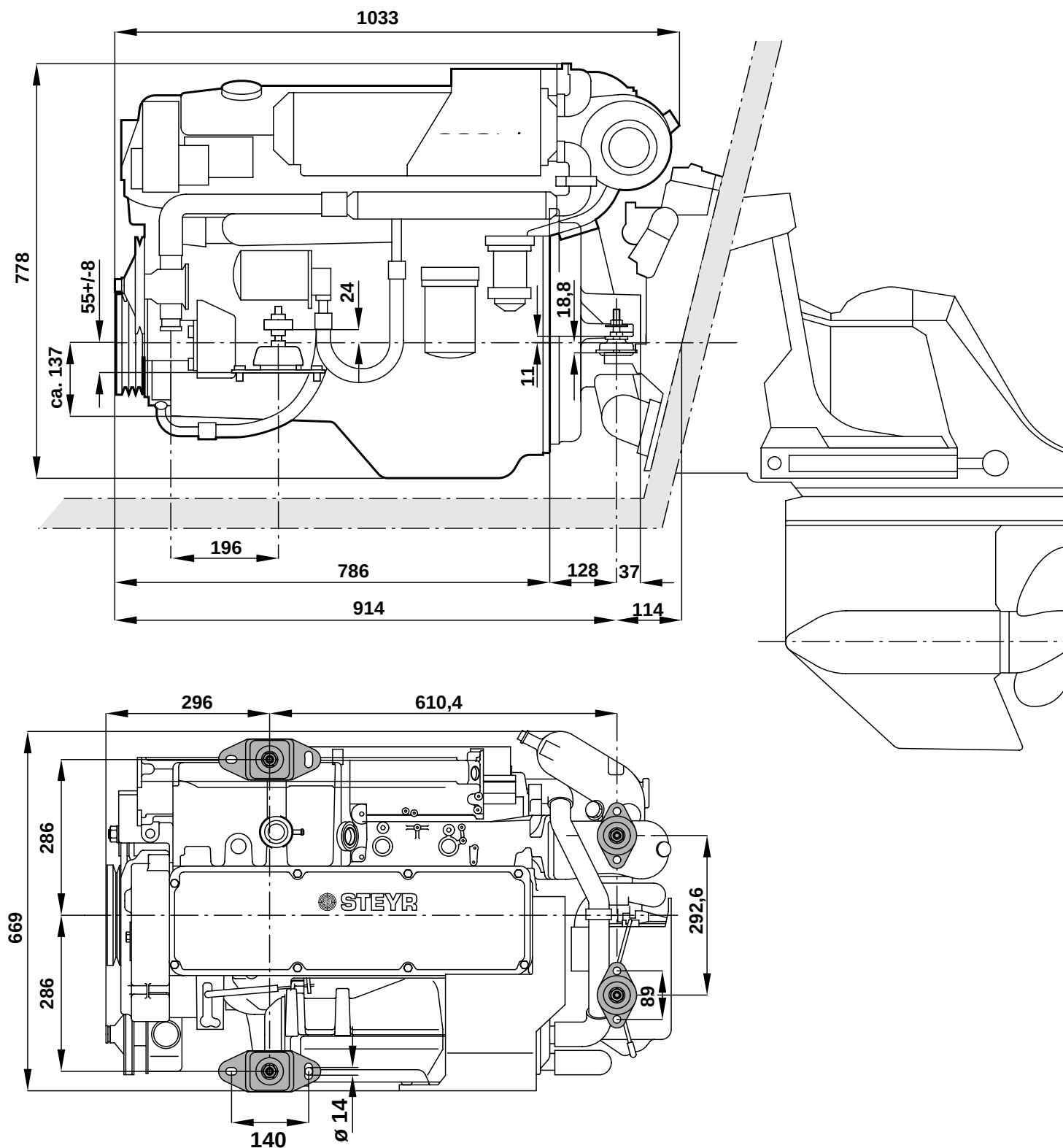


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Drill templates (scale approx. 1:10)

6 Cyl. Marine Engine

VOLVO SX Drive, King Cobra Drive

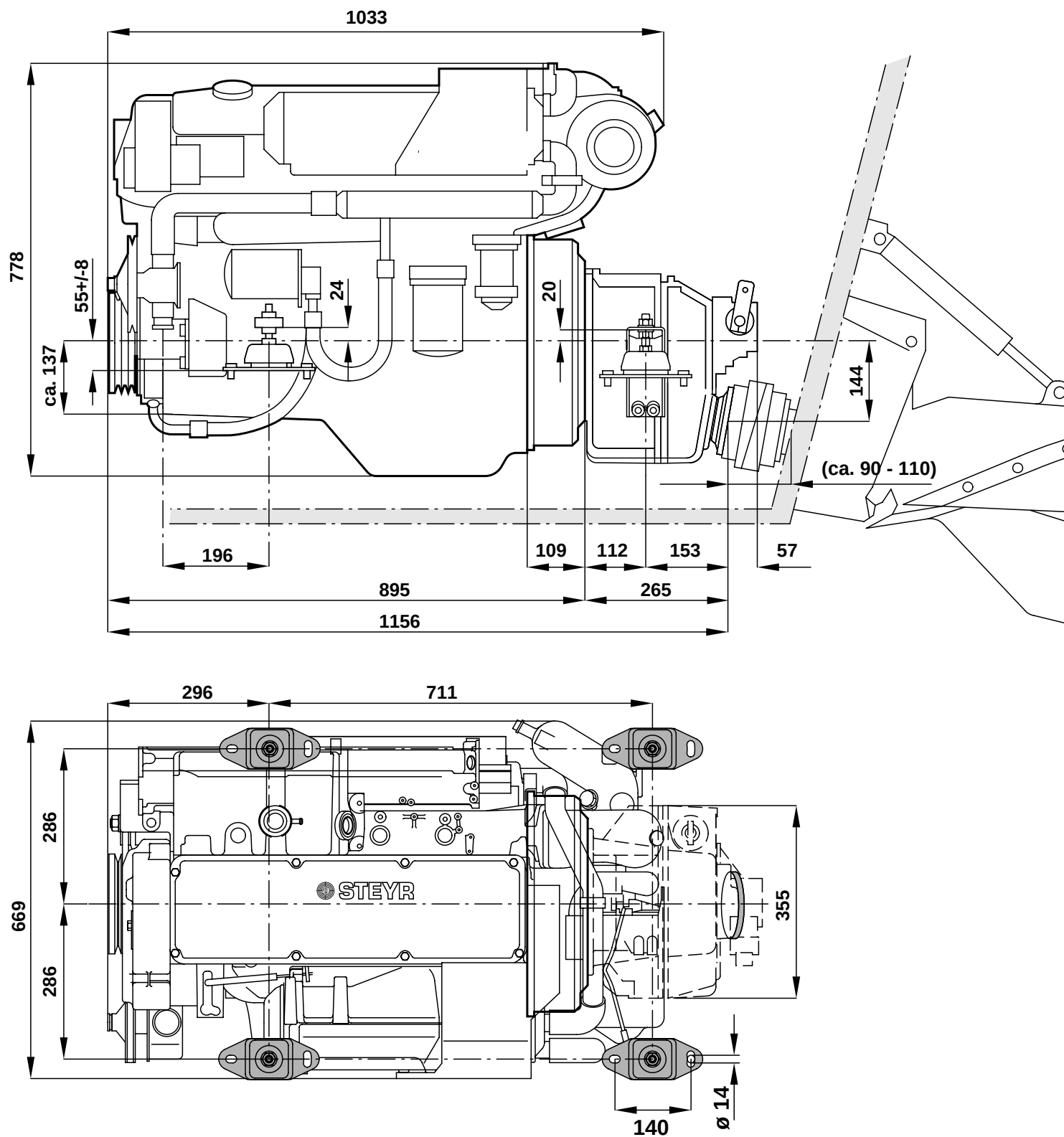


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Drill templates (scale approx. 1:10)

6 Cyl. Marine Engine

Tunnel Drive SARO
STEYR ENGINE + STP 320 - ZF 63 A (8°)



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18. APPENDIX

TABLE OF CONTENTS

PROPELLER CALCULATION FORM

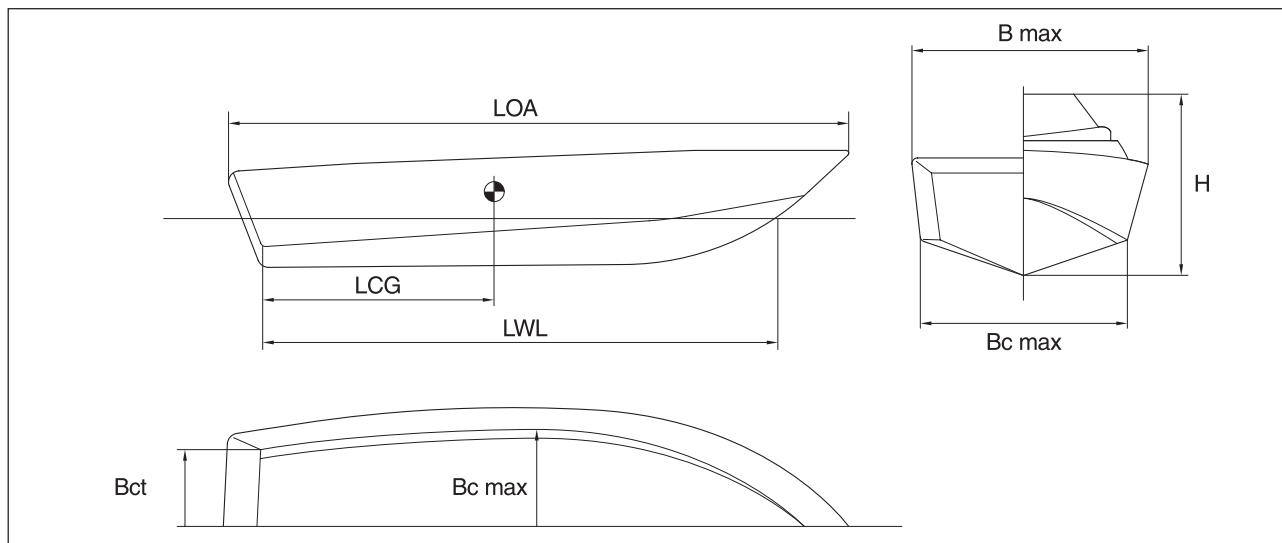
INSTALLATION AND PRE-DELIVERY INSPECTION LOG

OWNER IDENTIFICATION CARD

18. APPENDIX

NOTES

PROPELLER CALCULATION FORM



Manufacturer of boat:

Boat type:

Own weight: W min kg

Total weight: W max kg

Over-all length of boat: LOA m

Length of boat, over waterline: LWL m

Load centre of gravity, endwise (from transom): LCG m

Over-all width of boat: B max m

Width of boat, at water line: Bc max m

Width of boat, at transom: Bct m

Over-all height of boat: H m

V-angle boat centre: β at °

V-angle at transom: β t °

Engine model:

Gear:

Gear type:

Reduction of speed: :1

Shaft diameter: mm

Slope of shaft: °

Cone: 1:

Propeller Data:

Diameter: inch

Pitch: inch

Number of blades:

Sense of rotation:

Material:

Costs contribution to propeller computation **Euro 62,--** excl. VAT

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INSTALLATION AND PRE-DELIVERY INSPECTION LOG: ENGINE NO:.....	
Boat Owner: Company/Name: Address/Phone:	
Dealer: Company: Address/Phone:	
<i>Manual, warranty and operation explained</i> yes ☐ <i>Safeguarding instruction carried out</i> yes ☐	
Type of boat: Model No.: Dimension of propellers: Boat length: m Transmission: Boat weight: kg Gear reduction: Driving system: Engine type: Propeller: Engine model: Serial number:	
Level of operating fluids (motor oil, gear oil, hydraulic oil, cooling agent) checked ☐ yes	
Measuring data with rated power: Max. boat speed: Max. engine speed: Cross-sect. air intake duct eng.comp.: cm² Temperature engine compartment ° C Boost-pressure at max. rpm.: mbar Exhaust backpressure: mbar Motor oil pressure bar Engine coolant temperature: ° C Exhaust gas / raw water temperature: ° C Fuel rate of flow at idle run (measured from return line): l/min Idle speed: rpm. Name of datalog:	
Leakage (oil, fuel, coolant) checked: Instruments adjusted: Type of secondary drive (if available): Type of cabin heating (if available): 2nd control station (if available): CEL - extinguishes after 0,7 sec: YES NO Test made on:, by (Name in block letters)	
Please immediately return a copy of this report and the Warranty registration card to your STEYR MOTORS GENERAL DISTRIBUTOR. If not doing so, guarantee will expire!!	

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STEYR OWNER IDENTIFICATION CARD

Owner's

Name

Address

City

State

Zip

Date of commissioning

MODEL #

SERIAL #

STEYRMOTORS



DEALER RECORD CARD

ENGINE REGISTRATION	MODEL	SERIAL
OUT DRIVE REGISTRATION	MODEL	SERIAL
TRANSOM MOUNT REGISTRATION	MODEL	SERIAL

Owner's Name

Address

City

State

Zip

Date of commissioning

Ignition Key No.

Boat Mfg.

Hull No.

Boat Model

Boat Length

Owners signature

Important: The Federal Boat Safety Act requires registration list to be maintained on product sales by manufacturer and DEALER. This is a standard card on which a dealer can keep his records.

Name		
Address		
City	State	Zip
Date of commissioning	Type of Use	
	☐ Pleasure ☐ Comm'l ☐ Govt	

Dealer Name		
Address		
City	State	Zip
Owner's Phone	Dealer Code	

Engine Registration	Model #	Serial #
---------------------	---------	----------

Boat Mfg	Model
Hull No.	Length
Trailer Vin No.	
Rate Overall Quality of	
BOAT	☐ Good ☐ Acceptable ☐ Poor
MOTOR	☐ Good ☐ Acceptable ☐ Poor

STEYRMOTORS



WELCOME ABOARD

YOUR GUARANTEE OF WARRANTY PROTECTION

Present this card to your Authorized Dealer should you require warranty service. It will assist you in obtaining service by verifying your ownership and date of purchase. When in need of an Authorized Dealer to service your STEYR Product when away from home consult your Yellow Pages. If no listing is available, please call 0043/7435-501-0 or contact us on our e-mail address office@steyr-motors.com or through our homepage www.steyr-motors.com

STEYR MOTORS WARRANTY REGISTRATION CARD

Sold to
Sold by

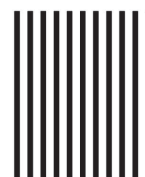
217916127

BUSINESS REPLY MAIL

STEYRMOTORS



STEYR MOTORS GmbH
WARRANTY REGISTRATION DEPT.
IM STADTGUT B1
4407 STEYR-GLEINK, AUSTRIA



NO
POSTAGE
NECESSARY

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